

Project Manual

Volume 3 – Divisions 21 - 34



Prepared for:

West Chester Area School District

782 Springdale Drive
Exton, PA 19341

Project:

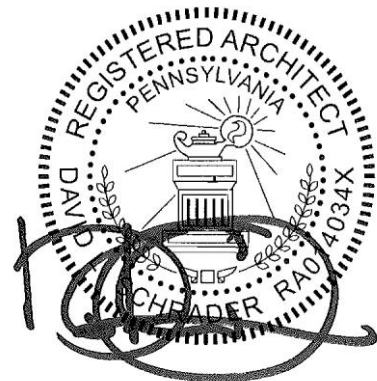
**Hillsdale Elementary School
Additions & Renovations**

725 West Chester market Street
West Chester, PA

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GC REBID Bid Documents:

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PART 1 - GENERAL

1.1 FIRE UNDERWRITER SEAL:

- A. Where applicable, all material shall bear the National Board of Fire Underwriters' Seal of Approval. Certificates to this effect to be furnished to Architect upon request.

1.2 DEFINITION OF WORK RESPONSIBILITY:

- A. All electrical control components including starters required for operation of Fire Protection equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides fire protection equipment. See Div. 26 specifications for starters, combination starters, and switches.
- B. Power wiring from panelboards or similar source through all equipment disconnects to motors or heating equipment shall be furnished and installed by the Electrical Contractor.
- C. Equipment disconnect switches, unless otherwise specified or supplied by the equipment supplier as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.
- D. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the electrical specifications.
- E. All base flashing, where required, shall be by the Roofing Contractor, with necessary counter-flashing by this contractor.
- F. All structural work needed for support of mechanical equipment or components shall be provided by this contractor unless shown on structural plans.

1.3 RULES AND REGULATIONS:

- A. All work shall be performed in accordance with the rules and regulations of the ICC Codes, local plumbing code ordinances, NFPA Code, and the public utilities having jurisdiction.
- B. All work shall be performed in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.
- C. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.

- D. The Owner will obtain the building permit. Any other fees relative to the contractor's work shall be paid by the contractor as part of his bid.
- E. Contractor's must be licensed within the Township which the project is located. Copies of these licenses must be posted within the respective job trailers during construction.

1.4 ANCHOR BOLTS:

- A. Each Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished by him under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.
- B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.
- C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.5 DRAWINGS:

- A. The accompanying drawings are a part of these specifications and are intended to show approximate and relative locations of services and equipment. They shall not be scaled to determine exact positions, locations and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.
- C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to consult other trades, this Contractor shall rearrange his work at his own expense.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT AND MATERIALS

- A. Refer to Division 1.
- B. Contractor shall include with each submittal/shop drawing, a matrix outlining all items that do not match the specified unit. If an item is not listed on the matrix, the submitted unit will be assumed to meet all parts of the specification. Contractor will be responsible to ensure that the specifications are met in full. Items in matrix shall include scheduled performance data vs. submitted performance data, specified components vs. submitted unit components, specified construction weight, warranty, etc. vs. submitted construction, weight, warranty, etc.

1.7 VISIT TO THE SITE:

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all costs and change made necessary by such conditions.

1.8 COORDINATION OF WORK:

- A. Contractor shall coordinate his work with that of other trades. In case of interference or problems the Architect shall decide which work is to be relocated, regardless of which is installed first.

1.9 LOCATION OF EQUIPMENT:

- A. All locations of fire protection equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.
- B. This Contractor shall obtain Architect approval of all arrangement drawings before continuing his work.

1.10 MATERIALS AND EQUIPMENT:

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.11 WORKMANSHIP:

- A. All workmanship shall be done according to the best practices of the trade by qualified and competent tradesmen.

1.12 PROTECTION OF EQUIPMENT:

- A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- B. He shall schedule material and systems for deliver in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.

- C. This Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.13 SCAFFOLDING AND HOISTING:

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.14 FOREMAN:

- A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.15 SLEEVES:

- A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.
- B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal.
- C. Where sleeves pass through foundation walls, the space between such sleeves and passing pipes shall be caulked with graphite packing and an approved plastic and waterproof caulking compound as approved by the Architect. In lieu of caulking materials, Contractor has option of using preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.
- D. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
- E. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material.

1.16 CONCRETE AND MASONRY WORK:

- A. The Contractor shall furnish and install all concrete bases, reinforcing, etc. required to install the Mechanical Work, unless otherwise noted.
- B. The Contractor, prior to installing any forms, reinforcing or concrete, shall notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete. No such work shall be placed in a manner to interfere with the proper placing of the reinforcement unless so authorized by the Architect.

1.17 ESCUTCHEONS:

- A. All exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces, shall be provided with solid pattern heavy ceiling, floor or wall escutcheons with set screw. Escutcheons and plates shall be of steel or malleable iron with prime coat ready for painting. Escutcheons will not be provided where sleeves intentionally extend above finished floor.
- B. All exposed plumbing short branch connections to fixtures and/or equipment passing through wall or floors shall be equipped with pressed brass, chromium plated, solid-type escutcheons.
- C. Provide angle collars at ducts where they pass through finished walls, floors and ceilings.

1.18 ACCESS DOORS AND PANELS:

- A. All ceiling and wall access panels required shall be furnished by this Contractor and set by the General Contractor. The location of these access panels must be approved by the Architect prior to their installation. The Contractor shall furnish an access panel where fire dampers, valves, specialties, junction boxes, and other serviceable items are installed behind plaster, tile, or similar type non-removable surfaces.
- B. Panels shall be of suitable size and construction for each specific location. Doors shall be flush and shall open 175 degrees on concealed hinges. All assemblies shall be rustproof and exposed finished edges and surfaces shall be prime-coated with rust inhibitive paint. Doors to be installed in ceilings shall be with screw driver operated cam locks. Doors for wall installation shall have master-keyed cylinder locks. Doors shall be Milcor, or equal, as follows:

1.	Construction	Milcor Model
	a. Masonry	Style M
	b. Plaster	Style K

1.19 CUTTING AND PATCHING:

- A. Contractor shall give the General Contractor complete information as to size of openings to be provided by the General Contractor in new floors, and walls, etc., so that such openings may be provided as the project progresses.

- B. If openings are omitted or are incorrect through failure of Contractor to follow these instructions, the Contractor shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Architect.
- C. The Prime Contractor shall be responsible for the cutting of existing floor slabs for the installation/demolition of any underground piping systems required by the documents. The Prime Contractor is responsible for proper bedding, backfill materials and compaction (as outlined in the specifications and on the drawings) to an elevation that is level with the bottom of the existing concrete floor slab. The Prime Contractor is responsible for the patching of the floor slab, with proper materials which are equivalent to the adjacent finishes and materials. The new finished floor will be provided by the General Contractor.
- D. Cutting and patching of exposed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All hole's cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.
- E. Cutting and patching of concealed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All hole's cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.
- F. Where it becomes necessary to cut out any portions of walls, floors, ceilings, roof or other portions of the building for the installation of work as may be required to perform and complete the work under this Contract, the Contractor shall do all necessary cutting and fitting, shall remove all excess material, and shall replace all work damaged so as to leave the entire premises in a finished condition. Refer to Contractor Responsibility Notes on Drawings.
- G. No cutting shall be done which may in any way affect the building structurally or architecturally. Any damage incident to cutting or other causes in the performance of this Contract shall be made good by replacement or repairs. Cutting shall be done only with the prior approval of the Architect. Refer to Contractor Responsibility Notes on Drawings.

1.20 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of two years from date of acceptance by Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period. Compressors shall have an additional 4-year warranty.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

1.21 CLEANING OF SYSTEMS:

- A. The Contractors shall thoroughly clean all pipe systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.
- B. All strainers shall be opened and cleaned thoroughly.
- C. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.22 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance, and operation of equipment installed by him.
- B. Three copies of factory maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.23 SUBSTITUTIONS:

- A. Refer to Division 01 for requirements in addition to the following:
 - 1. Various items of equipment and materials that have been used as the basis for fire protection system design have been specified by a manufacturer's name and model number. Another manufacturer's product may be submitted for consideration as a substitute. The Architect shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each of the Contractor's substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation. It shall be the responsibility of the Contractor to make certain that substitute equipment, which has been accepted by the Architect will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.

2. If any changes are required in the installation of mechanical or electrical services to any mechanical equipment accepted as substitutions to the basis of design, Fire Protection Contractor shall be responsible for any additional costs incurred to the Owner, Engineer, other prime contractors, and costs incurred for changes to the coordination drawings

1.24 ALTERNATES:

- A. Refer to Division 01 for requirements in addition to the following:

1. Various items of equipment and materials that have been used as a basis for mechanical system design have been specified by a manufacturer's name and model number. Where another manufacturer's product has been specified as an alternate to this equipment the proposed cost for this alternate shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports and supporting structure, fittings, ductwork, motors, controls, electrical wiring and thermal insulation. It shall be the responsibility of the contractor to make certain the alternate equipment will fit into the designated spaces. He shall make the necessary field measurements to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.

1.25 ALIGNMENT:

- A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.
- B. The Fire Protection Contractor shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS:

- A. Refer to Division 01 for requirements in addition to the following:

1. The Contractor shall prepare for the Owner, 3 hard bound volumes, each containing all operating instructions and information necessary for the care and maintenance of the system. These volumes shall be complete in every respect, and shall include detailed operating instructions for each piece of equipment and diagrams for control wiring and piping so arranged and detailed that the maintenance staff may trace the control in the event of operational malfunctioning.
2. The Contractor shall submit 1 of the hard-bound volumes to the Architect for approval prior to presenting same to Owner.

3. The purpose of this manual is to assist the Owner in routine operation, maintenance, servicing, troubleshooting and procurement of replacement parts. All information in the manual shall be as-built and only material pertinent to the project shall be included.
4. The operating manual shall be considered a part of the final inspection and shall be submitted for approval at least 30 days in advance of a request for final inspection. The manual shall include:
 - a. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.
5. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and troubleshooting techniques.
6. A listing of all items of mechanical and electrical equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.
 - a. Copies of all A.S.M.E. pressure vessel certifications, state police approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.
 - b. All of the materials shall be indexed, arranged categorically and be bound in a rigid, plastic covered, three ring binder.
7. The Contractor shall provide Project Records documents in accordance with requirements of Division 01.
8. O & M's must be provided once equipment is taken over by the Owner.
9. Warranty starts when Owner takes over that phase/space.

1.27 PAINTING:

A. Refer to Division 07 in addition to the following:

1. Provide corrosion inhibiting prime coating on all ferrous materials.
2. Paint all metal laid underground with one heavy coat of corrosion protective materials.
3. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted 1 prime coat and 2 coats of best quality oil paint of color as selected by the Architect.
4. Unless specifically noted, insulation and galvanized piping in ceiling cavity area shall not be painted.

END OF SECTION 210100

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SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire Suppression system requirement for sprinkler systems.
- B. Piping and Fittings
- C. General Valves

1.2 RELATED REQUIREMENTS

- A. Division 09 - Painting and Coating: Preparation and painting of fire protection piping systems.
- B. Section 210553 - Identification for Fire Suppression Piping and Equipment: Piping Identification.
- C. Section 21 1300 - Fire-Suppression Sprinkler and Standpipe Systems: Sprinkler and Standpipe systems design.

1.3 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings; The American Society of Mechanical Engineers; 2003 (ANSI/ASME B16.5).
- C. ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings; The American Society of Mechanical Engineers; 2007.
- D. ASME B16.25 - Buttwelding Ends; The American Society of Mechanical Engineers; 2007.
- E. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.
- F. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2007.
- G. ASTM A 795/A 795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2008.
- H. AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm Through 1200 mm), for Water and Other Liquids; American Water Works Association; 2003.

- I. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2007 (ANSI/AWWA C111/A21.11).
- J. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002, and Errata 2002 (ANSI/AWWA C151/A21.51).
- K. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2016.
- L. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances; National Fire Protection Association; 1995.
- M. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.
- N. UL 262 - Gate Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2004.
- O. UL 312 - Check Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2004.
- P. UL 1091 - Butterfly and Ball Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2005.

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers catalogue information. Clearly indicate exact models/model number, options, and accessories to be provided. Indicate applications where the submitted product is to be used. Indicate design pressure and ratings.
- C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
 - 1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.
- D. Project Record Documents: Record actual "as installed" locations of piping, sprinklers, components, and tag numbering and submit as "Record Set" after completion of all installation work.
- E. Operation and Maintenance Data: Include installation instructions and spare parts lists.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 01 - Product Requirements, for additional provisions.

2. Extra Valve Stem Packings: Two for each type and size of valve.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- B. Installer and Designer Qualifications: Company specializing in performing the work of this section with minimum 5 year's experience. approved by manufacturer.
- C. Conform to UL requirements.
- D. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.
- F. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.7 EXTRA MATERIALS

- A. Provide cabinet, wrench, and spare sprinkler heads (quantities in accordance with NFPA13.)
- B. Provide two valve stem packings for each size and type of valve installed.

PART 2 - PRODUCTS

2.1 FIRE SUPPRESSION SYSTEMS

- A. Sprinkler Systems: Conform work to NFPA 13, IBC 2018, and IFC 2018, requirements of the Local A.H.J., and minimum requirements as indicated on FP Drawings and Division 21 Specifications.

2.2 ABOVE GROUND PIPING

A. Acceptable Manufacturers for Piping and Tubing:

1. Wheatland Tube Company; 900 Haddon Ave., Collingswood, NJ 08108-2162.
2. Allied Tube - Sprinkler; 16100 S. Lathrop Avenue, Harvey, IL 60426.

B. Threaded and Welded Steel Pipe (2" and smaller): Schedule 40 Sprinkler Pipe: ASTM A795, Type E, Grade A; or Schedule 40 Pipe ASTM A-53. UL listed and FM approved for use as sprinkler piping. Black mill coating.

C. Fittings:

1. All fittings shall be pressure rated for minimum 250 psig working pressure.
2. Welded Steel Fittings: ASME B16.9, wrought steel, buttwelded, ASTM A 234/A 234M, wrought carbon steel or alloy steel, or ASME B16.5, steel flanges and fittings. Welding Materials in accordance with ASME Code.
3. Threaded Malleable Iron Fittings: ASME B16.3, threaded fittings.
4. Mechanical Grooved Fittings as manufactured by Victaulic ONLY: ASTM A536 ductile iron or ASTM A53 carbon steel fittings with grooved ends designed to accept Victaulic couplings. FireLock® or standard fittings.
5. Mechanical Grooved Couplings as manufactured by Victaulic ONLY: Ductile iron housing clamps with tapered seat to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - a. Saddle type - U-bolt style hole cut Mechanical -T's shall not be permitted for use on this project. Hole cut Mechanical-T's shall be Victaulic Style 920 or 920N and installed in strict accordance with manufacturer's instructions.
 - b. Rigid Couplings: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.
 - 1) 1-1/4" to 4": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock® EZ Style 009.
 - 2) 5" and Larger: Standard rigid coupling. Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
 - c. Flexible Couplings: Use in seismic areas where required by NFPA 13.
 - 1) 2" to 6": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic™.
 - 2) 8" and Larger: Standard flexible coupling. Victaulic Style 75 or 77.
 - 3) Coupling gaskets shall be listed for use as follows:
 - d. Coupling gaskets shall be listed for use as follows:
 - 1) Dry System (Ambient Temperature) - FlushSeal® or EZ Style 009 design, Grade EPDM, Type A
 - 2) Dry Freezer Applications (-30°F to 0°F) - FlushSeal®, Grade L, Silicone
 - 3) Wet System (Ambient Temperature) - C-Shape or EZ Style 009 design, Grade EPDM, Type A

6. Flanged Adapters: ASTM A536 ductile iron casting, flat faced, designed for incorporating flanged components with ANSI Class 150 bolt-hole pattern. Victaulic Style 741.
7. Victaulic Aquaflex stainless steel sprinkler fitting system: In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic Aquaflex Multiple-use Flexible Stainless-Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless flexible tube, a zinc plated steel 1" male nipple for connection to branch line piping, and a zinc plated steel reducer with a ½" or ¾" female thread for connection to the sprinkler head.
 - a. The drop shall include a UL-2443 approved and FM-1637 listed series AH2 braided hose with bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for (5) bends at 36" length, (7) bends at 48" length, (9) bends at 60" length and (10) bends at 72" length.
 - b. Union joints shall be provided for ease of installation. The flexible drops shall attach to the ceiling grid using a one-piece open grate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed and FM approved for sprinkler services to 175psi.
 - a. All hoses shall be factory pressure tested to 400psi
 - b. Approvals
 - i.FM-1637
 - ii.UL-2443
 - c. Refer to the Victaulic I-AQUAFLEX installation manual and the Victaulic Aquaflex Design guide, as shown in product submittal to ensure proper installation.
 - d. Contractor, upon completion of sprinkler system, shall provide the Owner/ Architect/Engineer with a letter from the flexible drop manufacturer stating that the installation has been inspected and approved.

2.3 PIPE HANGERS AND SUPPORTS

- A. Acceptable Manufacturers for Piping Hangers and supports:
 1. TOLCO Inc.
 2. Grinnell
 3. Provide hangers and supports as manufactured by the listed acceptable manufacturers or equal as approved by owner/architect.
- B. Hangers for Pipe Sizes ¾ inches thru 1½ inches: Adjustable swivel ring, MSS-SP-69 Type 10, Carbon steel, or Adjustable Clevis, MSS-SP-69 Type 1, Carbon steel.
 1. Adjustable swivel ring: TOLCO Inc. - Fig.200 or equal.
 2. Adjustable clevis: TOLCO Inc. - Fig.1 or equal.
 - a. Provide bolt spacer in all applications where seismic restraint is required.
- C. Hangers for Pipe Sizes 2 inches and Over: Adjustable Clevis, MSS-SP-69 Type 1, Carbon steel.
 1. Adjustable Clevis: TOLCO Inc. - Fig.1 or equal.

- a. Provide bolt spacer in all applications where seismic restraint is required.
- D. Armovers and end of branch: Adjustable swivel ring with surge restrainer, MSS-SP-69 Type 10, or carbon steel adjustable clevis, MSS-SP-69 Type 1.
 - 1. Adjustable swivel ring: TOLCO Inc. - Fig.200 or equal w/ Fig.25 surge Restrainer
 - 2. Adjustable clevis: TOLCO Inc. - Fig.1 or equal.
- E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- F. Wall Support: Welded steel bracket and wrought steel clamp.
- G. Vertical Support: Steel riser clamp, MSS-SP-69 Type 8.
 - 1. Steel Riser Clamp: TOLCO Inc. - Fig.6 or equal.
- H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- I. Structural Attachments
 - 1. Reversible C-Type Beam Clamp, MSS-SP Type 19 - TOLCO Inc. Fig. 65 & Fig. 66 with Beam clamp retaining strap or equal as approved by Owner/Architect.
 - 2. Bar Joist Hanger, TOLCO Inc. Fig. 61T (up to 4" pipe)
 - 3. Threaded side Beam Bracket, TOLCO Inc. Fig. 58 (up to 4" pipe)
 - 4. Provide additional steel to support work from structural framing members as required where support is required between framing members.
- J. Victaulic Style 009, 005, and 07 rigid couplings, with angle-pattern bolt pads, may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA 13. An adequate number of Victaulic Style 177, 75 and 77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

2.4 GATE VALVES

- A. 2-1/2 inches to 8 inches:
 - 1. UL Listed FM approved, Iron body, bronze trim, OS&Y rising stem pre-grooved for mounting tamper switch, handwheel, solid rubber covered bronze or cast-iron wedge, flanged ends.
 - 2. UL Listed FM approved, ductile iron body, bronze mounted, OS&Y brass rising stem, cast iron bonnet, EPDM coated cast iron disc, handwheel, groove x groove or groove x flanged ends, optional supervisory switch. Victaulic Series 771H or Series 771F.

2.5 GLOBE OR ANGLE VALVES

A. Up to and including 2 inches:

1. Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity repackable under pressure.

B. Over 2 inches:

1. Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.6 BALL VALVES

A. Up to and including 2 inches:

1. Bronze two-piece body, brass, chrome plated bronze, or stainless-steel ball, Teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends with union.

B. Over 2 inches:

1. Cast steel body, chrome plated steel ball, Teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 10 inches and over, flanged.

2.7 BUTTERFLY VALVES

A. Bronze Body (up to 2 inches):

1. UL Listed, FM approved, Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device and preinstalled supervisory switch.

B. Ductile Iron Body (up to 4 inches)

1. UL Listed, FM approved, Ductile iron body, nickel plated ductile iron disc, Nitrile seat, Type 416 stainless steel two-piece stem, TFE-lined stainless-steel bearings, weather-proof actuator with pre-wired supervisory switches. Victaulic Series 765 (365 psi) and Series 705 (300 psi).

2.8 CHECK VALVES

A. 2 inches to 3 inches:

1. UL Listed, FM approved, ductile iron body, CF8M stainless steel disc, stainless steel spring, and brass shaft, nickel-plated seat with Nitrile O-ring, grooved ends, 365 psig maximum pressure rating. Victaulic Series 717H.

B. 4 inch to 12 inches:

1. UL Listed, FM approved, ductile iron body, EPDM coated ductile iron disc, stainless steel spring and shaft, welded-in nickel seat, grooved ends, 300 psig maximum pressure rating. Victaulic Series 717.

2.9 DRAIN VALVES

A. Ball Valve:

1. UL Listed, FM approved, Brass with cap and chain, 3/4-inch hose thread.

2.10 SLEEVES:

- A. Sleeves through foundation walls shall be preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.
- B. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe.
- C. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal.
- D. Unless otherwise specified or shown, sleeves shall be two pipe sizes larger than the overall outside diameter of the pipe when insulated.

2.11 ESCUTCHEONS:

- A. Solid pattern, heavy ceiling floor or wall escutcheons. Steel or Malleable iron with set screw. Prime coated ready for painting.
- B. Pressed brass, chromium plated, solid-type escutcheons.

2.12 ACCESS DOORS AND PANELS:

- A. Refer to Division 01 for requirements in addition to the following:
- B. Panels shall be of suitable size and construction for each specific location. Doors shall be flush and shall open 175 degrees on concealed hinges. All assemblies shall be rustproof and exposed finished edges and surfaces shall be prime-coated with rust inhibitive paint. Doors to be installed in ceilings shall be with screw driver operated cam locks. Doors for wall installation shall have master-keyed cylinder locks. Doors shall be Milcor, or equal, as follows:

- | | | |
|----|--------------|--------------|
| 1. | Construction | Milcor Model |
| | a. Masonry | Style M |
| | b. Plaster | Style K |

2.13 ANCHOR BOLTS:

- A. Anchor bolts must be the hook type and of proper size and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13 and the additional requirements below.
 - 1. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 4. Support vertical piping at every other floor. Provide one riser support on each floor where grooved piping is used. Support riser piping independently of connected horizontal piping.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 6. Provide additional supports as follows:
 - a. Provide minimum of two hangers on any grooved piping exceeding 11ft. in length.
 - b. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.
 - 1) Do not fasten or anchor work to concrete deck except where individually approved by Structural Engineer and Architect.
 - 2) Do not fasten or anchor any work directly to metal roof deck.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and work of other trades.
- D. Group piping whenever practical at common elevations.

- E. Provide sleeves when penetrating footings, floors, and walls and fill annular space between piping and sleeves.
 - 1. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
 - 2. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material and the sleeve shall be of a material as required to achieve fire resistance equivalent to fire separation required.
- F. Provide escutcheons on all exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces. Escutcheons will not be required where sleeves intentionally extend above finished floor.
- G. Install valves, specialties, and other serviceable items within accessible spaces. Provide access panels where valves, specialties, and other serviceable items are required to be installed behind plaster, tile, or similar type non-removable surfaces. Coordinate panel installation with G.C. in field.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Perform welding in accordance with ASME Code.
- J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Division 9 for painting requirements.
- L. Do not penetrate building structural members unless indicated.
- M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- N. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- O. Provide OS&Y gate or butterfly valves for shut-off or isolating service.
- P. Provide drain valves at main shut-off valves, low points of piping and apparatus.
- Q. Provide all concrete bases, reinforcing, etc. required to install the work of this section, unless otherwise noted. Prior to installing any forms, reinforcing or concrete, notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete.

- R. Provide all necessary anchor bolts as required for the various equipment specified herein, and set in place at the time the foundations, bases, or curbs are poured. Fill all spaces between the bolt sleeves, rough foundations, bases or curbs of the equipment with one inch of non-shrinking cement grout. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

END OF SECTION 210500

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SECTION 210553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.2 RELATED REQUIREMENTS

- A. Division 09 - Painting and Coating: Identification painting.

1.3 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.4 SUBMITTALS

- A. See Division 01.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Provide Zone valve drawing (to indicate what area is served by valve) and post at each valve.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Brady Corporation: www.bradycorp.com.

- B. Champion America, Inc: www.Champion-America.com.
- C. Seton Identification Products: www.seton.com/aec.
- D. Substitutions: See Division 01.

2.2 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

2.3 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter. Minimum information indicating fluid being conveyed (FP) and FP Zone where appropriate.
- B. Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
- B. Stencil Paint: As specified in Division 09, semi-gloss enamel, colors conforming to ASME A13.1.

2.5 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.6 CEILING TACKS

- A. At the completion of the project, this Contractor shall provide the Owner with a plan that indicates all valve locations for the project. The Owner will install a system of identification on the ceiling grid to locate the valves.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Division 09.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Provide additional labeling for location of equipment and valving as required by the Authority Having Jurisdiction. Coordinate work with Architect in field.
- F. Identify pumps and valves with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- G. Identify valves in main and branch piping with tags. Provide As-Built drawings identifying tag# and location of all valves.
- H. Tag automatic controls, instruments, and relays. Key to control schematic.
- I. Identify piping 2" and smaller, concealed or exposed, with plastic pipe markers. Identify piping 2-1/2" and larger, concealed or exposed, with stencils. Verify requirements for piping identification in finished areas with exposed piping with Architect in field. Identify all piping within Boiler Rooms with stencils. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification on horizontal piping not to exceed 20 feet on straight runs and at each side of penetration of structure or enclosure. Locate additional identification on risers and drops, adjacent to each Tee of main piping, and at each obstruction.

END OF SECTION 210553

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SECTION 211300 - FIRE-SUPPRESSION SPRINKLER AND STANDPIPE SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. System design, installation, and certification.
- C. Sprinkler Heads and Accessories
- D. Sprinkler Alarm Valves
- E. Supervisory and Monitoring Devices
- F. Sprinkler System Accessories and Equipment
- G. Standpipes
- H. Standpipe Valves

1.2 RELATED REQUIREMENTS

- A. Section 21 0500 - Common Work Results for Fire Suppression.
- B. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.
- C. Section 26 2726 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- B. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2016.
- C. NFPA 14 - Standard for the Installation of Standpipe Systems; National Fire Protection Association; 2016.
- D. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.
- E. IBC – International Building Code - 2018

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers data on all products specified within this section including sprinklers, valves, and specialties. Clearly Indicate exact models/model numbers, options, and accessories to be provided. Indicate the application where the materials are to be used where appropriate. Manufacturers data shall include the following information as appropriate for each product: product listings (UL, FM, ASSE, etc.) performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. System Drawings:
 - 1. Contractor shall prepare drawing submittals and hydraulic calculations for submittal to the Architect/Engineer, all local reviewing agencies having jurisdiction, and the owner's insurance carrier (I.S.O submittal necessary only when required by owner's insurance carrier). The shop drawings prepared by the contractor shall bear a fire protection engineer's seal, whom is registered in the Commonwealth of Pennsylvania. No work shall begin until all approvals are granted.
 - 2. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 - 3. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
 - 4. Submit shop drawings to authority having jurisdiction, and Fire Marshall for approval. Submit proof of approval to Architect\Engineer.
- D. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
- F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- G. Maintenance Materials: Furnish the following spare equipment for Owner's use in maintenance of project.
 - 1. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
 - 2. Sprinkler Wrenches: For each sprinkler type.
- H. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
- B. Conform to UL requirements.
- C. Designer Qualifications: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- E. Installer and Designer Qualifications: Company specializing in performing the work of this section with working knowledge of NFPA13 installation requirements with minimum 5 years' experience with fire protection systems similar to that required by this project. The
- F. Equipment and Components: Provide products that bear UL label or marking.
- G. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- H. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.
- I. To assure uniformity and compatibility of sprinklers within the fire protection system, all sprinkler heads shall be supplied by a single manufacturer.
- J. To assure uniformity and compatibility of piping specialties within the Fire Protection system, all products within each of the product families specified below shall be supplied by a single manufacturer.

1.6 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.8 TESTING

- A. Perform and document testing in accordance with NFPA-13, NFPA-14, NFPA-24, and the local Authority Having Jurisdiction.

- B. Testing shall be witnessed by the local Authority Having Jurisdiction and owner's representative. Coordinate scheduling of testing to allow attendance by all required representatives.

1.9 EXTRA MATERIALS

- A. Provide extra sprinklers of type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
- B. Provide suitable wrenches for each sprinkler type.
- C. Provide metal storage cabinet for spare sprinklers adjacent to main service entrance. Verify exact location with Owner Representative in field.

PART 2 - PRODUCTS

2.1 SPRINKLER SYSTEM

- A. Provide a "Design Build" Fire Suppression Sprinkler and Standpipe System in accordance with IBC 2018, NFPA 13, and NFPA-14 (2016 editions), and inclusive of all additional requirements as indicated on the drawings and in these specifications. The entire building shall be "sprinkled throughout" with "Quick Response" standard coverage sprinklers. No Extended coverage heads shall be permitted except where specifically noted on the Fire Protection drawings. All new and renovated building areas shall be provided with new sprinklers and system as noted on the FP series drawings. The entire Fire Suppression System shall be hydraulically calculated to provide the prescribed density uniformly over the most remote area in accordance with NFPA 13.
 - 1. Occupancy: Building predominantly Light Hazard, some areas of other classification in accordance with NFPA 13 and document drawings.
 - 2. Water Supply: Contractor shall provide flow test for use in hydraulically calculating the sprinkler system.
- B. Interface system with building control system.
- C. Provide Wet Manual Standpipes with hose connection valves where indicated on the FP drawings. Provide hose connection valves at each floor level. Refer to drawings for locations.
- D. Provide Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.
- E. Heads indicated on these plans are the "MINIMUM REQUIREMENTS". Any additional heads & piping, required to meet all codes, shall be provided as part of the original contract at no additional cost to the Owner.

2.2 WATER FLOW TEST

- A. Perform a new water flow test before preparing hydraulic calculations and use the results of this flow test as the basis for design of the sprinkler system.
- B. Submit water flow test data with Hydraulic Calculations.
- C. Existing Flow Test Data as Follows:

Static Pressure: 50 PSI (61-132)

Residual Pressure: 46 PSI (61-132)

Flow: 1126 GPM (96-127)

Location of Test: Hydrant 61-132 at West Market St. 450 ft. W/O Bradford Ave.
Hydrant 96-127 at Market St. 100 ft. E/O Bradford Ave.

2.3 SPRINKLER HEADS AND ACCESSORIES

- A. Acceptable Manufacturers
 - 1. All sprinkler heads shall be provided by from a single manufacturer.
 - 2. Viking Corporation.
 - 3. Victaulic.
 - 4. Tyco.
- B. Suspended Ceiling Type (ACT and GWB): Quick Response, Concealed pendant type with matching push on escutcheon plate.
 - 1. Finish: Brass.
 - 2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
 - 3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 - 4. Design Basis: Victaulic Model V38 series (Quick Response).
- C. Exposed Area Type: Quick Response, Standard upright or pendent type with chrome guard.
 - 1. Finish: Brass.
 - 2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 - 3. Design Basis: Victaulic Model V27 series (Quick Response).
- D. Sidewall Type: Quick Response, Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
 - 1. Finish: Enamel, color as selected.

2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA-13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
4. Design Basis: Victaulic Model V27 series (Quick Response).

E. Guards: Finish chrome.

2.4 WET PIPE SPRINKLER ALARM CHECK VALVE

A. Acceptable Manufacturers

1. *All Alarm Valve, Riser Check Valves, and Floor Zone Control Manifold Assemblies shall be provided by from a single manufacturer.
2. Viking Corporation.
3. Victaulic.
4. Tyco.

B. Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with variable pressure trim w/pressure retard chamber, and test and drain valve. Valve internal parts shall be replaceable without removing the valve from the installed position.

1. Design Basis: Victaulic FireLock® Series 751 w/Series 752 pressure retard chamber, and Style 720 TestMaster™ test and drain valve or Fire Lock 717R Riser Check Valve.

2.5 FLOOR ZONE CONTROL MANIFOLD ASSEMBLY

A. Acceptable Manufacturers

1. All Alarm Valve, Riser Check Valves, and Floor Zone Control Manifold Assemblies shall be provided by a single manufacturer.
2. Viking Corporation.
3. Victaulic.
4. Tyco.

B. Grooved end cast iron manifold for horizontal or vertical installation, including flow switch, pressure gauge, test and drain valve.

1. Design Basis: Victaulic FireLock® Series 747M

2.6 STANDPIPE HOSE CONNECTION VALVES

A. Acceptable Manufacturers

1. Potter Roemer.

2. Croker.
 3. Guardian Fire Equipment
- B. Angle type; brass finish; 2-1/2 inch (65 mm) size, N.S.T. thread to match fire department hardware, 300 psi (2070 kPa) working pressure, with threaded cap and chain of same material and finish. Provide additional 2½"x1½" N.S.T. thread reducer with cap and chain of same material and finish.
1. Design Basis: Potter Roemer: Model 4065
- C. Verify all requirements with local fire marshal and AHJ prior to order/installation.

2.7 WATER FLOW SWITCH

- A. Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.
1. ACCEPTABLE MANUFACTURERS
 - a. All flow, pressure and supervisory switches shall be provided by a single manufacturer.
 - b. Potter Roemer.
 - c. System Sensor.

2.8 PRESSURE SWITCH

- A. Acceptable Manufacturers
1. *All flow, pressure and supervisory switches shall be provided by from a single manufacturer.
 2. Potter Roemer.
 3. System Sensor.
- B. Pressure switch for mounting in upright position, with two contacts; rated 15 amp at 125 volt AC and 2.5 amp at 30 volt DC.

2.9 SUPERVISORY SWITCH

- A. OSY type supervisory switch, with two contacts; rated 15 amp at 125 volt AC and 2.5 amp at 30 volt DC.
1. ACCEPTABLE MANUFACTURERS
 - a. All flow, pressure and supervisory switches shall be provided by a single manufacturer.
 - b. Potter Roemer.
 - c. System Sensor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fire suppression system in accordance with all referenced standards and local codes.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Place pipe runs to minimize obstruction to other work.
- D. Place piping in concealed spaces above finished ceilings.
- E. Center sprinklers within ACT ceilings in two directions relative to scoring and grid patterns as noted on approved architectural reflected ceiling plans. Refer to Fire Protection Details on contract drawings for additional information on centering of sprinklers within various ceiling types and patterns.
- F. Align sprinklers symmetrically with other ceiling fixtures and elements as shown on approved architectural reflected ceiling plans.
- G. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- H. Flush entire piping system of foreign matter.
- I. Install guards on all exposed sprinklers except where noted otherwise.
- J. Hydrostatically test entire system.
- K. Require test be witnessed by Fire Marshal and authority having jurisdiction.
- L. Provide system training for Owner representatives to include required maintenance, system supervisory devices, operating equipment, etc.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system.

3.3 SCHEDULES

- A. System Hazard Areas:
 - 1. Lobby/Vestibules, Classrooms, Offices, Corridors, Library (Seating/General use areas), Game Rooms, Meeting/Conference Rooms, Toilet rooms, and similar spaces: Light Hazard.
 - 2. Mechanical Room, Storage Spaces, Janitors Closets, Commercial Kitchens, Mail Rooms, and similar spaces: Ordinary Hazard, Group 1.

3. Stages, Library (Stack areas) and similar spaces: Ordinary Hazard, Group 2.

END OF SECTION 211300

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SECTION 220100 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 FIRE UNDERWRITER SEAL:

- A. Where applicable, all material shall bear the National Board of Fire Underwriters' Seal of Approval. Certificates to this effect to be furnished to Architect upon request.

1.2 DEFINITION OF WORK RESPONSIBILITY:

- A. All electrical control components including starters required for operation of plumbing equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides the plumbing equipment. See Division 26 specifications for starters, combination starters, and switches.
- B. Power wiring from panel boards or similar source through all equipment disconnects to motors or heating equipment shall be furnished and installed by the Electrical Contractor.
- C. Equipment disconnect switches, unless otherwise specified or supplied by the equipment supplier as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.
- D. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the Division 26 electrical specifications.
- E. All base flashing, where required, shall be by the Roofing Contractor, with necessary counter-flashing by this contractor. Flashing shall comply with the requirements of Division 07.
- F. All structural work needed for support of mechanical equipment or components shall be provided by this contractor unless shown on structural plans.

1.3 RULES AND REGULATIONS:

- A. Contractor shall be licensed by the Municipality/Township in which the work is performed. Contractor is responsible for meeting all licensing requirements of the Municipality and securing all necessary certifications prior to beginning work.
- B. All work shall be performed in accordance with the rules and regulations of the ICC Codes, local plumbing codes, the utilities having jurisdiction, and the NFPA Code.
- C. All work shall be performed in accordance with the rules and regulations or Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.

- D. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.
- E. The Owner will obtain the building permit. Any other fees relative to the contractor's work shall be paid by the contractor as part of his bid.
- F. Contractor must be licensed within the Township which the project is located. Copies of these licenses must be posted within the respective job trailers during construction.

1.4 ANCHOR BOLTS:

- A. Each Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished by him under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.
- B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.
- C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.5 DRAWINGS:

- A. The accompanying drawings are a part of these specifications and are intended to show approximate and relative locations of services and equipment. They shall not be scaled to determine exact positions, locations and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping rises, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.
- C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical and other work shall be carefully examined. All work shall be coordinated prior to installation. Where physical interferences with his work occur because of his failure to coordinate with other trades, this Contractor shall rearrange his work at his own expense.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT AND MATERIALS

- A. Refer to Division 1 for additional submittal requirements.

- B. Contractors shall include with each submittal / shop drawing, a matrix outlining all items that do not match the specified unit. If an item is not listed on the matrix, the submitted unit will be assumed to meet all parts of the specification. Contractors will be responsible to ensure that the specifications are met in full. Items in matrix shall include scheduled performance data vs. submitted performance data, specified components vs. submitted unit components, specified construction weight, warranty, etc. vs. submitted construction, weight, warranty, etc.

1.7 VISIT TO THE SITE:

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all costs and change made necessary by such conditions.

1.8 COORDINATION OF WORK:

- A. Contractor shall coordinate his work with that of other trades. In case of interference or problems the Architect shall decide which work is to be relocated, regardless of which is installed first.

1.9 LOCATION OF EQUIPMENT:

- A. All locations of plumbing equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.
- B. The Mechanical Contractor shall prepare dimensioned coordination/arrangement drawings at a scale of (1/4" =1'0"). Layouts represented by these drawings shall be coordinated with all other trades.
- C. This Contractor shall obtain Architect approval of all arrangement drawings before continuing his work.

1.10 MATERIALS AND EQUIPMENT:

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.11 WORKMANSHIP:

- A. All workmanship shall be done according to the best practices of the trade by qualified and competent tradesmen.

1.12 PROTECTION OF EQUIPMENT:

- A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- B. He shall schedule material and systems for deliver in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.
- C. This Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.13 SCAFFOLDING AND HOISTING:

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.14 FOREMAN:

- A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.15 SLEEVES:

- A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.
- B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight galvanized steel pipe. Sleeves through concrete floor slabs and other partitions shall be 18 ga. galvanized steel or galvanized steel pipe.

- C. Where sleeves pass through foundation walls, the space between such sleeves and passing pipes shall be caulked with graphite packing and an approved plastic and waterproof caulking compound as approved by the Architect. In lieu of caulking materials, Contractor has option of using preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.
- D. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
- E. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material. Refer to Division 1 specifications for fireproofing requirements.

1.16 CONCRETE AND MASONRY WORK:

- A. The General Contractor shall furnish and install all concrete bases, reinforcing, etc. required to install the Mechanical Work, unless otherwise noted.
- B. The Contractor, prior to installing any forms, reinforcing or concrete, shall notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete. No such work shall be placed in a manner to interfere with the proper placing of the reinforcement unless so authorized by the Architect.

1.17 ESCUTCHEONS:

- A. All exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces, shall be provided with solid pattern heavy ceiling, floor or wall escutcheons with set screw. Escutcheons and plates shall be of steel or malleable iron with prime coat ready for painting. Escutcheons will not be provided where sleeves intentionally extend above finished floor.
- B. All exposed plumbing short branch connections to fixtures and/or equipment passing through wall or floors shall be equipped with pressed brass, chromium plated, solid-type escutcheons.
- C. Provide angle collars at ducts where they pass through finished walls, floors and ceilings.

1.18 ACCESS DOORS AND PANELS:

- A. All ceiling and wall access panels required shall be furnished by this Contractor and set by the General Contractor. The location of these access panels must be approved by the Architect prior to their installation. The Contractor shall furnish an access panel where fire dampers, valves, specialties, junction boxes, and other serviceable items are installed behind plaster, tile, or similar type non-removable surfaces.

- B. Refer to Division 08 Section "Access Doors and Frames" for access panel requirements.

1.19 CUTTING AND PATCHING:

- A. Contractor shall give the General Contractor complete information as to size of openings to be provided by the General Contractor in new floors, and walls, etc., so that such openings may be provided as the project progresses.
- B. If openings are omitted or are incorrect through failure of the prime Contractors to coordinate the required openings, the respective Contractors shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Architect.
- C. The Prime Contractor shall be responsible for the cutting of existing floor slabs for the installation/demolition of any underground piping systems required by the documents. The Prime Contractor is responsible for proper bedding, backfill materials and compaction (as outlined in the specifications and on the drawings) to an elevation that is level with the bottom of the existing concrete floor slab. Refer to Contractor Responsibility Notes on Drawings.
- D. Cutting and patching of exposed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All holes cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.
- E. Cutting and patching of concealed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All holes cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.
- F. Where it becomes necessary to cut out any portions of walls, floors, ceilings, roof or other portions of the building for the installation of work, and as may be required to perform and complete the work under this Contract, the Contractor shall do all necessary cutting and fitting, shall remove all excess material, and shall replace all work damaged so as to leave the entire premises in a finished condition.
- G. No cutting shall be done which may in any way affect the building structurally or architecturally. Any damage incident to cutting or other causes in the performance of this Contract shall be made good by replacement or repairs. Cutting shall be done only with the prior approval of the Architect.

1.20 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of two years from date of acceptance by Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period. Compressors shall have an additional 4-year warranty.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

1.21 CLEANING OF SYSTEMS:

- A. Contractor shall thoroughly clean all pipe systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.
- B. All strainers shall be opened and cleaned thoroughly.
- C. The interior of all air handling equipment, ductwork and all filters shall be cleaned thoroughly before the building is accepted by the Owner.
- D. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.22 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.
- B. Three copies of factory maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.23 SUBSTITUTIONS:

- A. Substitutions, if permitted, must comply with the requirements of the Instruction to Bidders for pre-bid substitutions and with Division 01 Section "Product Requirements" for post-bid substitutions.

- B. Various items of equipment and materials that have been used as the basis for mechanical system design have been specified by a manufacturer's name and model number. Another manufacturer's product may be submitted for consideration as a substitute. The Architect shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each of the Contractor's substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation. It shall be the responsibility of the Contractor to make certain that substitute equipment, which has been accepted by the Architect will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.
- C. If any changes are required in the installation of mechanical or electrical services to any mechanical equipment accepted as substitutions to the basis of design, Plumbing Contractor shall be responsible for any additional costs incurred to the Owner, Engineer, other prime contractors and costs incurred for changes to the coordination drawings

1.24 ALTERNATES:

- A. Various items of equipment and materials that have been used as a basis for mechanical system design have been specified by a manufacturer's name and model number. Where another manufacturer's product has been specified as an alternate to this equipment the proposed cost for this alternate shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports and supporting structure, fittings, ductwork, motors, controls, electrical wiring and thermal insulation. It shall be the responsibility of the contractor to make certain the alternate equipment will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.

1.25 ALIGNMENT:

- A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.
- B. Contractor shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS:

- A. Refer to Division 01 "Close-out Procedures" as well as the following.
- B. The Contractor shall prepare for the Owner, 3 hard bound volumes, each containing all operating instructions and information necessary for the care and maintenance of the system. These volumes shall be complete in every respect, and shall include detailed operating instructions for each piece of equipment and diagrams for control wiring and piping so arranged and detailed that the maintenance staff may trace the control in the event of operational malfunctioning.
- C. The Contractor shall submit 1 of the hard-bound volumes to the Architect for approval prior to presenting same to Owner.
- D. The purpose of this manual is to assist the Owner in routine operation, maintenance, servicing, troubleshooting and procurement of replacement parts. All information in the manual shall be as-built and only material pertinent to the project shall be included.
- E. The operating manual shall be considered a part of the final inspection and shall be submitted for approval at least 30 days in advance of a request for final inspection. The manual shall include:
 - 1. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.
 - 2. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and troubleshooting techniques.
 - 3. A listing of all items of mechanical and electrical equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.
 - 4. Copies of all A.S.M.E. pressure vessel certifications, state police approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.
 - 5. All of the materials shall be indexed, arranged categorically and be bound in a rigid, plastic covered, three ring binder.
- F. The Contractor shall provide Project Record (As-Builts) documents in accordance with requirements of Division 1.
- G. O & M manuals must be provided prior to equipment being turned over to the Owner.
- H. Warranty period shall begin after date of substantial completion.

1.27 PAINTING:

- A. Refer to Division 09 Section "Paintings and Coatings" for painting requirements as well as the following.

- B. Provide corrosion inhibiting prime coating on all ferrous materials.
- C. Paint all metal laid underground with one heavy coat of corrosion protective materials.
- D. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted 1 prime coat and 2 coats of best quality oil paint of color as selected by the Architect.
- E. All exposed gas piping within boiler rooms and mechanical rooms shall be painted yellow and identified as required in Division 22 specifications.
- F. Unless specifically noted, insulation and galvanized piping in ceiling cavity area shall not be painted.
- G. Painting of piping within exposed finished areas shall be by the G.C. Installation of piping by the prime contractor shall include cleaning, degreasing, and preparation of piping for final painting by G.C.

1.28 EARTHWORK:

- A. Refer to Division 31 as well as the following.
- B. Provide all excavating, backfilling, shoring, sheeting, pumping, bailing, etc., required for the installation of the work of this Section.
- C. Trench depths shall allow adequate cover over piping, walls shall be vertical and bottoms shall be instrument graded. Earth shall be scooped out under pipe hubs to provide a solid bearing for the barrel of the pipe on undisturbed earth. Concrete or other approved supports shall be provided for all pipes installed in fill.
- D. Carry pipe trenches in rock below the pipe invert at least 1/4 the nominal diameter of the pipe or a minimum of 4" below the bottom of the pipe whichever is the greater. Backfill space below pipe with crushed stone or gravel ranging in size from 1/4" to 3/4".
- E. Excavation under footings or foundations and deeper than the angle of repose from footings or foundations as determined by the Architect shall be backfilled solidly with 3,000-pound concrete, to such angle of repose and bottom of such footing or foundation. Where excavation damages existing lawns, sidewalks, roadways etc., such surfaces shall be restored to their original condition by the Contractor performing the excavation.
- F. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.
- G. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.

- H. All repair of macadam or concrete paving made necessary by work done under this contract shall be performed by Site Contractor at the expense of this contractor. All such repairs shall match surrounding paving in materials and workmanship.

END OF SECTION 220100

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SECTION 220501 - DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. This Contractor shall be responsible for the removal of existing piping, fixtures, ductwork or equipment in the existing building which is shown on the Drawings or which is in conflict with the new construction or new mechanical systems. Existing piping, equipment and ductwork which are removed shall be disconnected at their source and capped. Furnish all labor, equipment hauling, rigging, scaffolding, etc. necessary for the removal phase of the project.

1.3 GENERAL:

- A. Existing piping, fixtures, equipment, and related accessories which require systems to be shut-down shall be coordinated with the Owner. Periods of shut-down shall be minimal and all new work shall be planned and scheduled to accomplish as few shut-downs as possible.
- B. All construction and removal work shall be performed in a manner as to keep the existing systems in operation as the work progresses. Prior to commencing construction, the contractor shall review the construction schedule with the Owner and Architect to assure a well coordinated schedule.
- C. Remove as indicated on the drawings or as required existing waste, vent, water, gas, and storm water piping. Cap ends of piping which remain active.
- D. Cutting and patching shall be by this Contractor unless otherwise indicated. Refer to Contractor Responsibility Notes on Drawings.
- E. Remove or disconnect and cap existing piping (as indicated on the drawings) serving plumbing fixtures which are being removed.
- F. The Owner shall have the option of keeping any or all salvageable items removed from building such as draft barriers, unit ventilators, cabinet heaters plumbing fixtures, etc. Any items removed from the building that Owner does not wish to keep shall become the property of this Contractor and he shall dispose of these items.

END OF SECTION 220501

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SECTION 220502 - EXCAVATION, BACKFILL AND COMPACTION OF UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 31- Earthwork

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Excavation, backfill and compaction associated with utility construction including such related features as protection of adjacent utilities and structures, maintenance and protection of traffic, cutting paved surfaces, support of excavation, control of excavated materials, dewatering, piping, bedding, disposal of excavated materials, and all work related to providing all utilities and structures in connection with sanitary sewer piping.

1.3 DEFINITIONS

- A. Backfill: Stone materials or imported structural fill materials.
- B. Bedding Course: Layer placed over the excavated subgrade in a trench before laying a pipe.
- C. Utilities: Include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 SUBMITTALS

- A. Refer to Division 01 Specifications for submittal procedures
- B. Certificates: Submit certification attesting that the composition analysis of pipe embedment and select material stone backfill materials meet specification requirements.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

- B. Testing and Inspection Service: Owner shall hire an independent testing and inspection agency to perform all soil testing during earthwork operations.
- C. Testing Laboratory Qualifications: To qualify for acceptance, the testing laboratory must demonstrate to Architect's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct required field and laboratory testing without delaying the progress of the work.
- D. Testing & Inspection Agency: The Owner will provide and pay for the services of a Independent Testing & Inspection Agency who will have the responsibility of determining what subgrade is acceptable or unacceptable and must be removed by the Subcontractor. The imported fill or imported structural fill shall be installed and compacted under the direction and observation of the Independent Testing & Inspection Agency. The Independent Testing & Inspection Agency will also document quantities of all materials on a daily basis. The Independent Testing & Inspection Agency will also monitor other earthwork that the Owner determines.

1.6 PROJECT CONDITIONS

A. Excavation and Rock Removal:

1. General:

- a. The Contractor shall complete the excavation as indicated on the drawings and in Division 01.
- b. When excavation has reached required subgrade elevations, notify Architect or Independent Testing & Inspection Agency, who will make an inspection of conditions. If the Independent Testing & Inspection Agency determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as to the extent directed by the Independent Testing & Inspection Agency.

2. Excavation Classifications: Refer to Division 01 and Division 31.

B. Compaction of Backfill:

- 1. Placing of Fill Materials: Place the specified structural fill, stone backfill and in all areas, in layers not more than 6" in loose depth for material compacted by heavy compaction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers.
- 2. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.
- 3. Place imported structural fill, backfill and fill materials evenly adjacent to structures to required elevations. Prevent wedging action of backfill against structured by carrying material uniformly around structure to approximately same elevation in each lift.

4. Compaction: Provide fill compaction to minimum percentage of density specified for each area classification indicated below. Correct improperly compacted area or lifts as directed by Architect or Construction Manager if density tests indicated inadequate compaction.
 - a. Percentage of Maximum Density Requirements: Compact to not less than the following percentages of maximum dry density, in accordance with ASTM D 698.
 - 1) Under concrete building slabs, under concrete foundations and footings, compact each layer of imported structural fill material at 98 percent of maximum dry density. Extend compacted area beyond the exterior face of the building a distance equal to the depth of fill at that area but not less than 10 feet.
 - 2) Under exterior concrete and asphalt paving compact each layer of backfill or fill material at 98 percent of maximum dry density.
 - 3) Under lawn or unpaved areas, compact each layer of backfill or fill material at 95 percent of maximum dry density.
 - 4) At exterior face building foundation walls and walls beyond the exterior of the face of the building, each layer of backfill or fill shall be compacted to 95 percent of maximum dry density.
 - 5) At asphalt and concrete paving the top 6 to 8 inches of subgrade under the paving and aggregate base course shall be compacted to 98 percent of the maximum dry density. The aggregate base course shall also be compacted to 100 percent of the maximum dry density.

C. Protection of Existing Utilities and Structures:

1. Take all precautions and utilize all facilities required to protect existing utilities and structures. In compliance with Act 199 (2004) of the General Assembly of Pennsylvania, advise each Utility at least three (3) working days in advance of intent to excavate, do demolition work and give the location of the job site. Request cooperative steps of the Utility and suggestions for procedures to avoid damage to its lines.
2. Advise each person in physical control of powered equipment used in excavation or demolition work of the type and location of utility lines at the job site, the Utility assistance to expect, and procedures to follow to prevent damage.
3. Immediately report to the Utility and the Architect any break, leak or other damage to the lines or protective coatings made or discovered during the work and immediately alert the occupants of premises of any emergency created or discovered.
4. Allow free access at all times for purposes of maintenance, repair and inspection.

1.7 COLD WEATHER PROTECTION

- A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

PART 2 - PRODUCTS

2.1 PIPE BEDDING OR EMBEDMENT MATERIAL

- A. Refer to details on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Layout utility trenchwork and establish extent of excavation by area and elevation. Designate and identify datum elevation and project engineering reference points. Set required lines, levels, and elevations.
- B. Notify Architect of unexpected subsurface conditions and discontinue work in area until notified to resume work.
- C. Maintain and protect existing utilities identified by utility users within the Work area.
- D. Verify that structure walls are braced to support surcharge forces imposed by backfilling operations.

3.2 PROTECTION OF ADJACENT WORK

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Grade excavation top perimeter to prevent surface water runoff into excavation or to adjacent properties.

3.3 EXCAVATION

- A. Width of Excavation:
 - 1. Pipelines:
 - a. Excavate trenches, including laterals, to a width necessary for placement and jointing of the pipe, and for placing and compacting pipe embedment under, around and over the pipe.
 - b. Shape trench walls completely vertical from trench bottom to at least two (2) feet above the top of the pipe.

- c. For pressure pipeline fittings, excavate trenches to a width that will permit placement of concrete thrust blocks. Provide earth surfaces for thrust blocks that are perpendicular to the direction of thrust and are free of loose or soft material.

B. Length of Open Trench:

- 1. Do not advance trenching operations more than 200 feet ahead of completed pipeline.

3.4 SUPPORT OF EXCAVATION

- A. Support excavations with sheeting, shoring, and bracing or in the case of pipeline construction, a "trench box" as required to comply with State, and local laws and codes.
- B. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through negligence or fault of contractor in any other manner, shall be repaired at contractor's expense.
- C. Withdraw shoring, bracing, and sheeting as backfilling proceeds unless otherwise directed by the Architect.
- D. The neglect, failure or refusal of the Architect to order the use of bracing or sheeting, or a better quality, grade, or section, or larger sizes of steel or timber, or to order sheeting, bracing, struts, or shoring to be left in place, or the giving or failure to give orders or directions as to the manner or methods of placing or driving sheetings, bracing, jacks, wales, stringers, etc., shall not in any way or to any extent relieve Contractor of any responsibility concerning the condition of excavation or of any of his obligations under the Contract, nor shall any delay, whether caused by any action or want of action on the part of Contractor, or by any act of Owner and Architect or their agents, or employees, resulting in the keeping of an excavation open longer than would otherwise have been necessary, relieve contractor from the necessity of properly and adequately protecting the excavation from caving or slipping, nor from any of their obligations under the Contract relating to injury of persons or property, nor entitle them to any claim for extra compensation.

3.5 DEWATERING

- A. Keep excavations dry and free of water. Dispose of precipitation and subsurface water clear of the work.
- B. Maintain pipe trenches dry until pipe has been jointed, inspected, and backfilled, and concrete work has been completed. Prevent trench water from entering pipelines under construction.

3.6 PIPE LAYING

- A. Provide required pipe bedding placed in accordance with the Drawing Details and Specifications.
- B. Shape recesses for the joints or bell of the pipe by hand. Assure that the pipe is supported on the lower quadrant for the entire length of the barrel.
- C. Lay pipe as specified in the appropriate Section of these Specifications for pipeline construction.

3.7 BACKFILLING EXCAVATIONS

- A. Pipeline Trench:
 - 1. After pipe installation and inspection, provide material to complete the pipe embedment in accordance with the Drawing Details and Specifications.
- B. Lift Thickness Limitations:
 - 1. Lift thicknesses shall be limited to 4 inches for pipe embedment, and 6 inches maximum for pipeline trenches within paved areas and non-paved areas and for structure excavations. In no case shall maximum lift thickness placed exceed the maximum limits specified by the manufacturer's recommendations for the compaction equipment to be utilized. Compaction equipment shall not be used over the pipe until sufficient backfill has been placed to insure that such equipment will not damage or disturb the pipe.
- C. Unsuitable Backfill Material:
 - 1. Where the Independent Testing & Inspection Agency or Architect determines backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with suitable backfill material. Unsuitable material shall be legally disposed of, off-site by the contractor.

3.8 FIELD QUALITY CONTROL

- A. Engage a qualified independent testing and inspection agency to perform field inspections and tests during trenchwork operations. Laboratory, inspection service, and Independent Testing & Inspection Agency shall be subject to acceptance by the Architect.
- B. Quality Control Testing During Construction: The testing laboratory shall inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

3.9 DISPOSAL OF EXCAVATED MATERIAL

- A. No excavated material shall remain after completion of backfilling. Excavated material shall be removed from the construction area, and disposed of legally, off-site.

3.10 CLEANUP

- A. Upon completion of trenchwork operations, clean areas within contract limits, remove tools and equipment. Provide site clear, clean, free of debris, and suitable for site work operations.

END OF SECTION 220502

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SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- D. Operation Data: Include instructions for safe operating procedures.
- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.3 QUALITY ASSURANCE

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Manufacturers:
 - 1. Century

2. A.O. Smith
3. Lincoln
4. Baldor
5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.

B. Construction:

1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 40 degrees C environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Provide motors with phase loss protection.

D. Contractor shall provide all motors that are required. Each motor shall be the correct service type and have a horsepower rating that is adequate for the device it is intended to drive. Motors shall not exceed their full load rating, including the service factor rating, whenever the driven equipment is operating at the specified capacity under normal operating conditions.

E. Motors shall be comparable to GENERAL ELECTRIC Tri/Clad, Type K, NEMA "T" rated units or substitute equipment that is approved by the Architect/Engineer. Insulation shall be Class B. Motors shall be dripproof in dry, non-hazardous locations, weather protected where exposed to the weather or dampness, and totally enclosed, fan cooled where specified. Dripproof and totally enclosed fan cooled motors, fractional and integral horsepower, shall have service factor ratings of 1.15 and 1.0 respectively. Fractional horsepower motors shall have sealed, permanently lubricated, ball bearings unless sleeve bearings are standard with a manufacture of equipment which utilized direct driven fans. Integral horsepower motors shall have ball bearings with grease zerk fittings and drain ports. All motors shall be rated for continuous duty. Maximum temperature rise shall not exceed 40 degrees C. for dripproof frame motors and 55 degrees C. for totally enclosed motors in a 40-degree C. ambient condition. Motors shall be suitable for the electrical service specified, scheduled or shown.

F. Motors shall have been tested and approved by the Underwriters' Laboratories, Inc. Motors shall be manufactured and classified in accordance with the current NEMA Standard Publication No. Mg 1 entitled "Motors and Generators."

G. Motors shall be dynamically balanced and tested at the factory before shipment. They shall be relatively quiet while running. Connections to direct driven devices shall be made with a flexible coupling. Motors for V-belt drive service shall be furnished with a steel base and a screw device for adjusting belt tension.

H. Motors shall be mounted so that they are readily accessible for maintenance. Motor terminal boxes shall be accessible. Covers shall not be blocked by other equipment. Watertight terminal boxes shall be provided on those motors in wet locations or where they are exposed to the weather. Motor mounting arrangement shall be such that the motor mounting bolts are accessible in order to facilitate its removal.

- I. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- J. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- K. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.2 MOTOR CONTROLLERS

- A. Contractor shall provide motor controllers. The items shall be products of one manufacturer, Allen-Bradley, Square D, General Electric or Westinghouse, and shall meet latest N.E.M.A. and IEEE Specifications. Starters and contactors shall be horsepower rated. Starters shall include the proper size heater elements
- B. Magnetic starters used with pressure or float switches, thermostats or similar maintained contact switches shall be provided with "On-Off-Auto" switches on the starter.
- C. Unless otherwise noted, control and pilot devices such as electric thermostats, alternators, float controls, aqua stats, etc., shall be furnished and installed by the Mechanical Contractor. Each device shall be provided with all auxiliary features and accessories which may be required for correct operation of the associated equipment.
- D. Magnetic starters shall be provided with start-stop pushbuttons on the starters unless remote control pushbuttons or other methods of starting are specified elsewhere.
- E. Unless otherwise noted elsewhere, all magnetic motor starters controlled with a remote pilot device shall contain a control circuit transformer, as an integral part of the controller, providing control power at a maximum 120 volts for the pilot device. The exact control circuit voltage shall be coordinated with the ATC supplier prior to the purchase of any motor controllers.
- F. Starters and protective devices which are provided as an integral part of the equipment furnished under the Mechanical Contracts, shall be supplied.
- G. For use in manual starting of fractional horsepower motors up to but not including 1/2 horsepower, the Mechanical Contractor shall furnish a thermal manual toggle switch type starter with pilot light specifically designed for this purpose. Each starter shall be provided with proper size heater element for the motor to be controlled. Heater elements shall be readily removable and interchangeable. Starters shall be arranged for flush or surface mounting as indicated or as required.

H. Controllers and wiring diagrams shall be delivered to the Electrical Contractor.

2.3 MOTOR DISCONNECTS:

- A. Unless otherwise noted, motors located out of sight of their respective electric panels shall be provided with disconnect switches at the motors by the Electrical Contractor.

2.4 ENCLOSURES:

- A. Motor controllers and disconnects shall be provided with standard approved enclosures to suit the locations in which they are installed and the conditions under which they are to operate.

2.5 MOTOR CONTROL WIRING:

- A. The Electrical Contractor shall run the power wiring system from the various supply panels indicated, to the motors and motor controllers and shall make final connections unless otherwise noted on the Drawings. Contractor shall run all control wiring from the motor controllers to the pilot devices.
- B. Starters, and protective control devices which are provided as integral part of the motors or motor-operated equipment shall be prewired at the factory.
- C. After final connections are completed, Contractor shall test each motor for proper rotation. Before applying current to the motor, Contractor shall check the motor for alignment, oil, etc. Contractor shall make any necessary adjustments to the starter and control equipment for proper starting and overload protection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 220513

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.

D. RELATED REQUIREMENTS

- 1. Section 22 0100 - General Provisions
- 2. Section 22 1005 - Plumbing Piping.

E. REFERENCE STANDARDS

- 1. ASTM A 269 - Standard Specification for Seamless and Welded Austenitic Stainless-Steel Tubing for General Service; 2008.
- 2. EJMA (STDS) - EJMA Standards; Expansion Joint Manufacturers Association; 2003.

1.2 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.

B. Product Data:

- 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- 3. Design Data: Indicate selection calculations.
- 4. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- 5. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- 6. Maintenance Data: Include adjustment instructions.

1.3 REGULATORY REQUIREMENTS

- A. Conform to UL requirements.

1.4 EXTRA MATERIALS

- A. See Division 01 - Product Requirements, for additional provisions.
- B. Supply two sets of packing for each packed expansion joint.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturers:

- 1. Flexonics.
- 2. Flexicraft Industries: www.flexicraft.com
- 3. Mason Industries: www.mason-industries.com
- 4. Metraflex Company: www.metraflex.com.
- 5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Construction

- 1. Inner Hose: Bronze.
- 2. Exterior Sleeve: Braided bronze.
- 3. Pressure Rating: 125 psi and 450 degrees F.
- 4. Joint: As specified for pipe joints.
- 5. Size: Use pipe sized units.
- 6. Maximum offset: 3/4 inch on each side of installed center line.

C. Application: Domestic Water - Copper piping.

2.2 EXPANSION JOINTS - TWO-PLY BRONZE BELLOWS TYPE

A. Manufacturers:

- 1. Mercer Rubber Company: www.mercer-rubber.com.
- 2. Metraflex Company: www.metraflex.com.
- 3. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Construction: Bronze with anti-torque device, limit stops, internal guides.

C. Pressure Rating: 125 psi and 400 degrees F.

D. Maximum Compression: 1-3/4 inches.

E. Maximum Extension: 1/4 inch.

F. Joint: Soldered.

G. Size: Use pipe sized units.

H. Application: Copper piping.

2.3 EXPANSION JOINTS - LOW PRESSURE COMPENSATOR WITH TWO-PLY BRONZE BELLOWS

A. Manufacturers:

1. Mercer Rubber Company: www.mercer-rubber.com.
2. Metraflex Company: www.metraflex.com.
3. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Working Pressure: 75 psi.

C. Maximum Temperatures: 250 degrees F.

D. Maximum Compression: 1/2 inch.

E. Maximum Extension: 5/32 inch.

F. Joint: Soldered.

G. Size: Use pipe sized units.

H. Application: Copper or steel piping 3 inches and under.

2.4 ACCESSORIES

A. Pipe Alignment Guides:

1. Two-piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1-inch thick insulation, minimum 3 inches travel.

B. Swivel Joints:

1. Bronze body, double ball bearing race, field lubricated, with rubber (Buna-N) O-ring seals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

1. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
2. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.

3. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
4. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
5. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION 220516

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pressure gages and pressure gage taps.
- B. Thermometers and thermometer wells.

1.2 RELATED REQUIREMENTS

- A. Section 22 0100 - General Provisions

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2005.
- B. ASTM E 1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2007.
- C. ASTM E 77 - Standard Test Method for Inspection and Verification of Thermometers; 2007.
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Underwriters Laboratories Inc.; 2005.

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.

1.5 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.6 EXTRA MATERIALS

- A. See Division 01 - Product Requirements. for additional provisions.
- B. Supply two bottles of red gage oil for static pressure gages.

- C. Supply two dial thermometers.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

- A. Manufacturers:
1. American Granby Inc.: www.americangranby.com
 2. Trerice, Inc.: www.trerice.com
 3. Weskler: weskler-gauges.com
 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
- B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
1. Case: Cast aluminum with phosphor bronze bourdon tube.
 2. Size: 4-1/2-inch diameter.
 3. Size: 2-inch diameter.
 4. Mid-Scale Accuracy: One percent.
 5. Scale: Psi.

2.2 PRESSURE GAGE TAPPINGS

- A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4-inch NPT for minimum 150 psi.
- C. Pressure Snubber: Brass with ss screen, and pigtail

2.3 STEM TYPE THERMOMETERS

- A. Manufacturers:
1. American Granby Inc.: www.americangranby.com
 2. Trerice, Inc.: www.trerice.com
 3. Weskler: weskler-gauges.com
 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
- B. Thermometers - Adjustable Angle: Red- appearing non-toxic liquid in glass; ASTM E 1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9-inch scale.
 2. Window: Clear Lexan.
 3. Stem: 3/4-inch NPT brass.

4. Accuracy: 2 percent, per ASTM E 77.
5. Calibration: Degrees F.

2.4 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2-inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide pressure gauges before strainers and on suction and discharge of each pump.
- C. Provide pressure gauge and thermometer on outlet of each water heater.
- D. Provide pressure gauge at each water service entrance.
- E. Provide pressure gauges and thermometer at all recirculation pump installations and as detailed on the plumbing drawings.
- F. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical, and in accordance with manufacturers recommendations.
- I. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- J. Locate test plugs adjacent thermometers and thermometer sockets.
- K. Provide pressure gauges on inlet and outlet side of every backflow preventer on the project.

3.2 SCHEDULES

- A. Pressure Gages, Location and Scale Range:
 1. Domestic Water Pumps, 0 to 100 psi.
 2. Sprinkler system, 0 to 250 psi.

- 3. Backflow preventers, 0 to 100 psi.
- B. Pressure Gage Tappings, Location:
 - 1. Balancing Control valves 3/4 inch & larger - inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Domestic hot water supply and recirculation, 0 to 200 degrees F.
- D. Thermometer Sockets, Location:
 - 1. Control valves 1 inch & larger - inlets and outlets.

END OF SECTION 220519

SECTION 220548 - VIBRATION AND ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Inertia bases.
- B. Vibration isolators.

1.2 SUBMITTALS

- A. Comply with pertinent provisions of Division 01.
- B. Product Data: Provide schedule of vibration isolator type with location and load on each.
- C. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.
- D. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.3 QUALITY ASSURANCE

- A. Product Qualification: Provide each type of vibration isolation unit produced by a specialized manufacturer, with not less than 5 years successful experience in the production of units similar to those for the project.
- B. Except as otherwise indicated obtain support isolation units from a single manufacturer.
- C. Engage the manufacturer to provide technical supervision of the installation of support isolation units produced by him, and of associated inertia bases.
- D. Manufacturer: Provide vibration isolation units manufactured by the following:
 - 1. Isolation Technology, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries
 - 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
- E. After installation is complete and while the system is operating, the vibration isolation Manufacturer and/or his qualified Representative shall conduct an inspection of the installation with the Contractor. The Representative will submit a written inspection report detailing any discrepancies, the Representative shall submit a report so stating. If there are discrepancies, the report shall detail corrective work to be done.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Isolation Technology, Inc: www.isolationtech.com.
- B. Kinetics Noise Control, Inc: www.kineticsnoise.com.
- C. Mason Industries: www.mason-ind.com.
- D. Substitutions: See Division 01 - Product Requirements.

2.2 INERTIA BASES

- A. Structural Bases:
 - 1. Construction: Welded structural steel with gusseted brackets, to support equipment and motor, with motor slide rails.
 - 2. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
- B. Concrete Inertia Bases:
 - 1. Construction: Structural steel channel perimeter frame, with gusseted brackets and anchor bolts, reinforcing; concrete filled.
 - 2. Mass: Minimum of 1.5 times weight of isolated equipment.
 - 3. Connecting Point: Reinforced to connect isolators and snubbers to base.
 - 4. Concrete: Minimum 3000 psi concrete.

2.3 VIBRATION ISOLATORS

- A. Open Spring Isolators:
 - 1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - 2. Spring Mounts: Provide with leveling devices, minimum 0.25-inch-thick neoprene sound pads, and zinc chromate plated hardware.
 - 3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
- B. Restrained Open Spring Isolators:
 - 1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - 2. Spring Mounts: Provide with leveling devices, minimum 0.25-inch-thick neoprene sound pads, and zinc chromate plated hardware.
 - 3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

4. Restraint: Provide heavy mounting frame and limit stops.

C. Closed Spring Isolators:

1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25-inch clearance.

D. Restrained Closed Spring Isolators:

1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25-inch clearance and limit stops.

E. Spring Hanger:

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
3. Misalignment: Capable of 20-degree hanger rod misalignment.

F. Neoprene Pad Isolators:

1. Rubber or neoprene waffle pads.
2. Configuration: Single layer.

- G. Rubber Mount or Hanger: Molded rubber designed for 0.4-inch deflection with threaded insert.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

B. Bases:

1. Set steel bases for one-inch clearance between housekeeping pad and base.

2. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
 3. Adjust equipment level.
- C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- E. Support piping connections to equipment mounted on isolators using isolators or resilient hangers to nearest flexible pipe connector.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.2 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.3 SUBMITTALS

- A. Labeling List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Piping: Tags.
- B. Pumps: Nameplates.
- C. Small-sized Equipment: Tags.
- D. Tanks: Nameplates.
- E. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- F. Water Treatment Devices: Nameplates.

2.2 GENERAL

- A. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or schedule. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: (Standpipe F12))
- C. Manufacturers
 - 1. Brady Corporation: www.bradycorp.com.
 - 2. Champion America, Inc: www.Champion-America.com.
 - 3. Seton Identification Products: www.seton.com/aec.
 - 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

2.3 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

2.4 VALVE TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black piping system abbreviation (1/4" high lettering) and sequenced valve numbers (1/2" high lettering), light contrasting background color and with 5/32" hole for fastener. Tag size minimum 1-1/2-inch diameter.
- B. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Valve Schedule: Provide valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
 - 1. Frame: For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB grade sheet glass.

2.5 STENCILS

A. Manufacturers:

1. Brady Corporation: www.bradycorp.com.
2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
3. Seton Identification Products: www.seton.com.
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8-inch-long color field, 1/2-inch-high letters.
2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8-inch-long color field, 3/4-inch-high letters.
3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12-inch-long color field, 1-1/4-inch-high letters.
4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24-inch-long color field, 2-1/2-inch-high letters.
5. Over 10 inch Outside Diameter of Insulation or Pipe: 32-inch-long color field, 3-1/2-inch-high letters.

C. Stencil Paint: As specified in Division 09, semi-gloss enamel, colors conforming to ASME A13.1.

2.6 PIPE MARKERS

A. Manufacturers:

1. Brady Corporation; Model: www.bradycorp.com.
2. Kolbi Pipe Marker Co.; Model: www.kolbipipemarkers.com.
3. Seton Identification Products; Model: www.seton.com.
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Comply with ASME A13.1.

C. Plastic Pipe Markers: Provide manufacturer's standard pre-printed, flexible or semi rigid, permanent, color coded, plastic sheet pipe markers, complying with ANSI A13.1. Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

1. All Piping: Provide snap-on application of pre-tensioned semi-rigid plastic full-bank pipe markers, extending 360 degrees around pipe at each location.
2. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.

3. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastics.

2.7 UNDERGROUND PLASTIC PIPE MARKERS:

A. Color code as follows:

1. Combustible Fluids: Brown with white letters.

B. Description: Manufacturer's standard 2" wide warning tape color coded and labeled to match pipe identification labels. Material shall be detectable polyester complying with ASTM B-721.

2.8 CEILING TACKS

A. Manufacturers:

1. Craftmark; Model: www.craftmarkid.com.
2. Substitutions: See Division 01

B. Description: Self-adhesive plastic coded dots. Color coded to match color of pipe marker.

C Color code as follows:

1. Plumbing Cold Water: Blue
2. Plumbing Hot Water: Red
3. Gas: Yellow

PART 3 - EXECUTION

3.1 PREPARATION

A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of coverings and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Degrease and clean all surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 INSTALLATION

A. Piping System Identification:

1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow:

2. Provide stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
3. Identify piping 2" and smaller, concealed or exposed, with plastic pipe markers. Identify piping 2-1/2" and larger, concealed or exposed, with stencils. Verify requirements for piping identification in finished areas with exposed piping with Architect in field. Identify all piping within Boiler Rooms with stencils.
4. Locate pipe markers and color bands on all piping within mechanical rooms, accessible maintenance spaces, and above acoustic tile ceilings. Where piping is exposed to view in occupied/finished spaces, verify identification requirements with Architect in field prior to installation. Locate additional pipe markers in each of the following locations.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - d. At access doors, manholes and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment. On piping above removable acoustical ceilings, omit intermediately spaced markers.
5. Provide underground warning tape for all underground piping outside the building approximately 6-8 inches below finish grade.

B. Valve Identification:

1. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
2. Provide valve finder ceiling dots at all concealed valve locations. Locate on ceiling grid not on ceiling tile.
2. Provide As-Built drawings identifying tag# and location of all valves. Provide valve schedule, mount valve schedule in frame(s) within Custodial rooms where indicated or, of not otherwise indicated, where directed by Owner/Architect.

C. Mechanical Equipment Identification:

1. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas pressure regulators.
 - b. Tanks and pressure vessels.

- D. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- E. Install tags with corrosion resistant chain.
- F. Apply stencil painting in accordance with Division 09.
- G. Install plastic pipe markers in accordance with manufacturer's instructions.
- H. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- I. Use tags on piping 3/4-inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- J. Identify valves in main and branch piping with tags.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.

1.2 RELATED SECTIONS

- A. Division 07 - Firestopping.
- B. Division 09 - Painting and Coating: Painting insulation jacket.
- C. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.3 REFERENCES

- A. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2004.
- B. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2005.
- C. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation; 2006.
- D. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2003.
- E. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2003.
- F. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.
- G. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- H. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum THREE years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 GLASS FIBER

- A. Manufacturers:
 - 1. Knauf Fiber Glass: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation: www.certainteed.com.
 - 5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
- B. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible.
 - 1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 850 degrees F.

3. Maximum moisture absorption: 0.2 percent by volume.
4. Insulation: ASTM C 547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
 - a. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
 - b. Maximum service temperature: 650 degrees F.
 - c. Maximum moisture absorption: 0.2 percent by volume.
5. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.
6. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12-inch centers.
7. Vapor Barrier Lap Adhesive:
 - a. Compatible with insulation.
8. Insulating Cement/Mastic:
 - a. ASTM C 195; hydraulic setting on mineral wool.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

1. Armacell International: www.armacell.com.
2. Nomaco Insulation: www.nomacoinsulation.com
3. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3; use molded tubular material wherever possible.

1. Minimum Service Temperature: -40 degrees F.
2. Maximum Service Temperature: 220 degrees F.
3. Connection: Waterproof vapor barrier adhesive.
4. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 JACKETS

A. PVC Plastic.

1. Manufacturers:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.
2. Jacket: One-piece molded type fitting covers and sheet material, off-white color.
3. Minimum Service Temperature: 0 degrees F.
4. Maximum Service Temperature: 150 degrees F.

5. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
6. 20/50 flame spread/smoke rating in accordance with ASTM E84
7. Thickness: 10 mil.
8. Connections: Brush on welding adhesive.
9. Factory-fabricated fitting covers
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

B. Stainless Steel Jackets

1. ASTM A 167 or ASTM A 240/A 240M.
2. 0.016 in. thick, smooth 2B finish

C. Aluminum Jacket

1. ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
2. 0.016 in. thick, smooth finish

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
 3. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

4. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - a. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - b. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
5. Inserts and Shields:
 - a. Application: Piping 1-1/2 inches diameter or larger.
 - b. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - c. Insert location: Between support shield and piping and under the finish jacket.
 - d. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - e. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
6. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.
7. Exposed Insulated Pipe (from floor penetration to 10 feet above finished floor): Finish with Stainless Steel or aluminum jacket.

3.3 SCHEDULES

- A. Plumbing Systems Insulation Schedule: (Provide insulation for piping and appurtenances of the following plumbing systems as scheduled below)
 1. Domestic Hot Water Supply and Recirculation, Tempered Supply:
 - (a) Glass Fiber Insulation (All-Service Jacket):
 - (1) Pipe Size Range:
 - (a) up to and including 1 inch: 1-inch thick
 - (b) 1-1/4 inch and over: 1-1/2 inch thick
 - (b) Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in concrete walls)
 - 1) Pipe Size range:
 - (a) Pipe Sizes up to and including 1 inch: 1-inch thick
 - (b) Pipe Sizes over 1-1/4 inch: 1-1/2 inch thick.
 2. Domestic Cold, and Non-Potable Water Supply:
 - (a) Glass Fiber Insulation (All-Service Jacket):
 - (1) Pipe Size Range:
 - (a) up to and including 2 inch: 1-inch thick
 - (b) 1-1/4 inch and over: 1-1/2 inch thick
 - (b) Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in concrete walls)
 - 1) Pipe Size range:
 - (a) Pipe Sizes up to and including 1 inch: 1-inch thick
 - (b) Pipe Sizes over 1-1/4 inch: 1-1/2 inch thick.

2. Roof Drain and Emergency Roof Drain Bodies:
 - a. Glass Fiber Insulation; Flexible Elastomeric Cellular Insulation
 - 1) 1-1/2-inch thick for Glass Fiberglass, 1 inch thick for Flexible Elastomeric Cellular Insulation
 - (a) Where service is concealed Flexible Elastomeric insulation in factory color is adequate. In exposed, finished areas (i.e. gymnasium, auditorium, etc.) painted Glass Fiber with all service jacket is required (color selected by Architect).
3. Rainwater and Emergency Rainwater Drainage Above Grade (all horizontal and all vertical piping):
 - a. Glass Fiber Insulation (All-Service Jacket):
 - 1) Thickness:
 - (a) all pipe sizes: 1-inch thick.
4. Cold Condensate Drains:
 - a. Flexible Elastomeric Insulation:
 - 1) Thickness:
 - (a) all pipe sizes: 3/4-inch thick.

END OF SECTION 220719

SECTION 221005 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe, Pipe Fittings, Pipe Hangers and Supports, Valves, and Miscellaneous connections for piping systems.
 - 1. Waste/Sanitary Sewer & Vent.
 - a. Plumbing Contractor shall provide complete Sanitary drainage and vent piping system as shown on plumbing drawings and specified herein including but not limited to all: piping, pipe fittings, pipe supports, pipe anchors, drains, and equipment/fixture connections to within 5'-0" beyond exterior footprint of building including final coordination and connection to Site Sanitary system.
 - 2. Kitchen Waste/Sanitary
 - a. Plumbing Contractor shall provide complete Kitchen Sanitary drainage and vent piping system as shown on plumbing drawings and specified herein including but not limited to all: piping, pipe fittings, pipe supports, pipe anchors, drains, and equipment/fixture connections to the extent indicated on the Contract Documents.
 - 3. Domestic Potable Water.
 - a. Plumbing Contractor shall provide complete Domestic Cold, Hot, and Hot Water Return, & Tempered water piping systems as shown on plumbing drawings and specified herein including but not limited to all: equipment, piping, valves, fittings, supports, anchors, insulation, connections to equipment/fixtures and plumbing specialties including final coordination and connection to existing Domestic Water Service on site at existing curb valve that was provided for future. Extend new Domestic Water Service from new connection point on site to building.
 - 4. Rainwater/Storm Water & Emergency Rainwater.
 - a. Plumbing Contractor shall provide complete Rainwater/Storm water piping system as shown on plumbing drawings and specified herein including but not limited to all: piping, pipe fittings, pipe supports, pipe anchors, drains, and insulation to within 5'-0" beyond exterior footprint of building including final connection to Site Storm water system.
 - 5. Condensate Drain Piping
 - a. Plumbing Contractor shall provide condensate drainage piping as shown on the plumbing drawings and specified herein (refer to below floor slab storm water piping) including but not limited to all: piping, pipe fittings, drains, etc. to connection to building Storm water system or discharge point as noted on the drawings.
 - 6. Natural Gas
 - a. Plumbing Contractor shall provide complete Natural gas distribution system as shown on plumbing drawings and specified herein including but not limited to all: equipment, regulators, piping, valves, fittings, supports, anchors, connections to equipment/fixtures and plumbing specialties beginning at the outlet of gas service meter. Plumbing Contractor shall coordinate installation of new gas service piping and meter with PECO.

- b. Plumbing Contractor shall be the project contract representative and coordinator with PECO for this project.

1.2 RELATED REQUIREMENTS

- A. Division 07 - Firestopping.
- B. Division 09 - Painting and Coating.
- C. Section 22 0100 - General Provisions
- D. Section 22 0553 - Identification for Plumbing Piping and Equipment.
- E. Section 22 0719 - Plumbing Piping Insulation.
- F. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
- G. Section 22 1006 - Plumbing Piping Specialties

1.3 REFERENCE STANDARDS

- A. Work and products provided in conformance to referenced standards listed below shall be in conformance with the latest editions of the referenced standards where the standards have a revision more current than the edition noted below.
- B. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- C. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- F. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers; 1968.
- G. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2004 (ANSI/ASME B31.9).
- H. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2007.
- I. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.

- J. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2006.
- K. ASTM B 32 - Standard Specification for Solder Metal; 2004.
- L. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.
- M. ASTM B 306 - Standard Specification for Copper Drainage Tube (DWV); 2002.
- N. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2003a.
- O. ASTM D 1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.
- P. ASTM D 2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.
- Q. ASTM D 2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings; 2007b.
- R. ASTM D 2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems; 2004.
- S. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2008.
- T. ASTM D 2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2004.
- U. ASTM D 2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.
- V. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).
- W. ASTM D 3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2006.
- X. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002, and Errata 2002 (ANSI/AWWA C151/A21.51).
- Y. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).
- Z. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2005.
- AA. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2004.

AB. IBC2018 - ICC - International Building Code; 2018

AC. IPC2018 - ICC - International Plumbing Code; 2018

AD. IFGC2018 - ICC - International Fuel Gas Code; 2018

AE. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2002.

AF. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

AG. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

AH. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

AI. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.

AJ. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2018.

1.4 SUBMITTALS

- A. Piping & Pipe fitting Product Data: Provide manufacturer's data on pipe materials and pipe fittings specified herein. Submittals shall clearly indicate exact materials to be provided and applications where the submitted product is to be installed. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
- B. Hangers & Supports, Valve, & Misc. Product Data: Provide manufacturer's data for Hangers & supports, valve, & miscellaneous piping products specified herein. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
- C. Project Record Documents: Record actual locations of valves. Provide valve schedule as required in Section 22 0553 "Identification for Plumbing Piping and Equipment".
- D. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data in Maintenance Manual.
- E. Review of submittals which do not clearly indicate the information noted above may be delayed or rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Division 01 - Product Requirements, for additional provisions.
2. Valve Repacking Kits: One for each type and size of valve.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Pennsylvania UCC standards, and all ordinances adopted by the local Authority Having Jurisdiction.

1. Maintain one copy on project site.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Piping

1. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
2. Welder Qualifications: Certified in accordance with ASME (BPV IX) or ANSI B31.1 as applicable.
3. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.
4. Manufacturers: Firms regularly engaged in the manufacture of piping products of types and sizes required, and which have been in satisfactory use for not less than five years in similar service.
5. Welding: Certify welding procedures, welders and operators in accordance with ANSI B31.1, paragraph 527.5 for shop and job site welding of piping work.
6. All grooved joint couplings, fittings, valves, and specialties shall be the products manufactured by Victaulic Co. or America. Grooving tools shall be of the same manufacturer as the grooved components.
7. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

D. Valves: Manufacturer's name and pressure rating marked on valve body.

1. Manufacturers: Firms regularly engaged in the manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.
2. Marking of Valves: Comply with MSS SP-25.
3. Valve Dimensions; For face-to-face and end-to-end dimensions of flanged or welding-end valve bodies, comply with ANSI B16.10. Grooved end valves shall comply with manufacturer's published dimensional data, with grooved ends complying with ANSI/AWWA C606.
4. Valve Types: Provide valves of same type by same manufacturer.

1.6 REGULATORY REQUIREMENTS

A. Perform Work and inspections/testing in accordance with State of Pennsylvania building codes including but not limited to IPC, IFGC, IBC, and IFC (Latest editions), and all requirements of the local Authority Having Jurisdiction.

- B. Service piping to the building shall be tested in accordance with all requirements of the Local Authority Having Jurisdiction and Municipal Water Authority.
- C. Conform to International Plumbing Code and all requirements of the local authority having jurisdiction, and Water Authority for installation of backflow prevention devices, service valving, and metering.
- D. Provide certificate of compliance from local water authority having jurisdiction indicating approval of installation of backflow prevention devices, service valving, and meters.
- E. When a meter pit is required, provide certificate of compliance from the local water authority having jurisdiction indicating approval of water meter pit construction plans prior to order/installation of water meter pit and all associated piping.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Provide factory applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from outside of pipe and tube.
- E. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable waterproof wrapping.
- F. Protect steel flanges and fittings from moisture and dirt by inside storage and enclosure or packaging with durable, waterproof wrapping.

1.8 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

1.9 EXTRA MATERIALS

- A. See Division 01 - Project Requirements, for additional provisions.
- B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

- 2.1 Except as otherwise indicated, provide factory fabricated products of the size, joint type, or class (thickness) indicated for each service. Where size, joint type, or class (thickness) is not indicated, provide products as determined by the installer for installation requirements and comply with the standards of the International Plumbing Code, International Fuel Gas Code, NFPA, Cast Iron Soil Pipe Institute (CISPI), and EPA as appropriate for each service.
- A. All Sanitary, Waste, and Vent piping above grade or slab, including piping within crawl spaces, shall be Cast iron - no hub piping as specified. All Sanitary, Waste, and Vent buried below slab or grade shall be schedule 40 PVC or Cast Iron Hub and Spigot Piping as specified.
- 2.2 WASTE/SANITARY SEWER & VENT PIPING, BURIED BELOW SLAB AND BURIED WITHIN 5 FEET OF BUILDING
- A. Cast Iron Pipe: ASTM A 74 service weight (Provide extra heavy weight where required by local Authority Having Jurisdiction).
1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
 2. Fittings: Cast iron.
 3. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C 564 neoprene gaskets conforming to ASTM C 1563, or lead and oakum.
- B. PVC Pipe: Schedule 40 ASTM D 2665 or ASTM D 3034. (No foam core permitted) - PVC Piping option for Sanitary Sewer and Waste piping systems shall not be permitted in areas with high temperature drainage discharge, these areas include but are not limited to: Kitchens, Boiler/Mechanical Rooms, etc. In areas with high temperature drainage discharge, Cast Iron Pipe shall be used in lieu of PVC piping. This cast iron pipe shall extend beyond the affected area to a minimum of 10ft. beyond the most downstream high temperature drain connection.
1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 2. Fittings: PVC (DWV Pattern).
 3. Joints: Solvent welded, with ASTM D 2564 solvent cement.
- 2.3 WASTE/SANITARY & VENT PIPING, ABOVE SLAB AND WITHIN CRAWL SPACES
- A. Cast Iron Pipe: CISPI 301, hubless.
1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
 2. Fittings: Cast iron.
 3. Joints: CISPI 310, ASTMC-564 neoprene gaskets and 300 series stainless steel clamp-and-shield assemblies with .0075in minimum thickness shield, and two clamps for sizes 1-1/2"-4", four clamps for sizes 5"-10", six clamps for sizes 12" and larger.

2.4 KITCHEN/SANITARY SEWER (GREASE WASTE) & VENT PIPING, BELOW SLAB

- A. Cast Iron Pipe: ASTM A 74 service weight (Provide extra heavy weight where required by local Authority Having Jurisdiction).
 - 1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
 - 2. Fittings: Cast iron.
 - 3. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C 564 neoprene gaskets conforming to ASTM C 1563, or lead and oakum.

2.5 KITCHEN WASTE (GREASE WASTE), ABOVE FLOOR SLAB WITHIN THE KITCHEN

- A. 18/8 Stainless Steel Pipe: ASTM A 74 service weight with FRM (fluorine rubber Vitron) sealing rings.
 - 1. Manufacturers:
 - a. Blucher
 - b. Josam Stainless Steel
 - 2. Fittings: 18/8 Stainless Steel.
 - 3. Joints: Hub-and-spigot, compression type with "FPM" fluorine rubber sealing rings.

2.6 DOMESTIC POTABLE WATER PIPING, ABOVE SLAB (piping 2-1/2" and larger only)

- A. For Domestic Potable Water Piping, above slab, in pipe sizes 2-inch and smaller refer to Specification Section 221116.
- B. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
 - 1. Fittings:
 - a. ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - b. Copper Press Fittings (all pipe sizes): Shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. Copper press fittings shall be EPDM. Copper press fittings shall be manufactured by Viega and installed utilizing Rigid Tool Company as "Pro Press System". Complete installation shall comply with manufacturers recommendations.
 - 2. Joints:
 - a. Press Fit Joints (All Sizes): ProPress (as specified above)
 - b. Larger than 3": Copper Plated Grooved Mechanical couplings as manufactured by Victaulic, No substitutions permitted.
 - 3. Unions (Pipe Sizes 2" and Under):
 - a. Copper tube and pipe: Class 150 bronze unions with soldered joints.
 - 4. Flanges (Pipe Size Over 1 Inch):
 - a. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

2.7 DOMESTIC POTABLE WATER PIPING, BELOW SLAB

A. Copper Tube: ASTM B 88 (ASTM B 88M), Type K (A).

1. Fittings: No fittings or joints permitted below grade
2. Joints: No fittings or joints permitted below grade

2.8 STORM PIPING & CONDENSATE PIPING, BELOW SLAB AND BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A 74 service weight. (Provide extra heavy weight where required by local Authority Having Jurisdiction).

1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
2. Fittings: Cast iron.
3. Joint Seals: Hub-and-spigot, CISPI HSN compression type with ASTM C 564 neoprene gaskets conforming to ASTM C 1563, or lead and oakum.

B. Pipe: Schedule 40 ASTM D 2665 or ASTM D 3034, if allowed by local codes and authorities. (no foam core permitted).

1. Manufacturers:
 - a. Charlotte Pipe and Foundry.
2. Fittings: PVC (DWV Pattern)
3. Joints: Solvent welded, with ASTM D 2564 solvent cement

2.9 RAINWATER & EMERGENCY RAINWATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless.

1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
2. Fittings: Cast iron.
3. Joints: CISPI 310, ASTM C-564 neoprene gaskets and 300 series stainless steel clamp-and-shield assemblies with .0075in minimum thickness shield, and two clamps for sizes 1-1/2"-4", four clamps for sizes 5"-10", six clamps for sizes 12" and larger.

2.10 NATURAL GAS PIPING, ABOVE SLAB

A. Steel Pipe: ASTM A 53/A 53M Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron threaded, or ASTM A 234/A 234M, wrought steel welding type.
2. Joints: NFPA 54, threaded or welded to ASME B31.1.
3. Unions (Pipe Sizes 2" and Under):
 - a. Ferrous pipe: Class 150 malleable iron threaded unions.

- b. Flanges (Pipe Size Over 1 Inch):
 - 1) Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2.11 CONDENSATE DRAIN PIPING, BELOW SLAB

A. PVC Pipe: ASTM D 2665 or ASTM D 3034. (No Foam Core Permitted)

- 1. Fittings: PVC.
- 2. Joints: Solvent welded, with ASTM D 2564 solvent cement.

2.12 FLANGES, UNIONS, AND COUPLINGS

A. Unions (Pipe Sizes 2" and Under):

- 1. Ferrous pipe: Class 150 malleable iron threaded unions.
- 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges (Pipe Size Over 1 Inch):

- 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
- 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Unions/Connections: Provide standard products recommended by manufacturer for use in service indicated which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

- 1. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier
- 2. Manufacturer: Subject to compliance with requirements, provide dielectric unions of one of the following:
 - a. Atlas Products Co.
 - b. Capital Mfg. Co., Div. of Harsco Corp.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. FMC Corp.
 - f. McNally, Inc.
 - g. PSI Industries.
 - h. Stockham Valves and Fittings.

2.13 MISCELLANEOUS PIPING FABRICATION MATERIALS:

- A. Forged Branch Connection Fittings: Except as otherwise indicated, provide the type as determined by the installer to comply with installation requirements.

- B. Pipe Nipples: Fabricate from same pipe as used for connected pipe; except do not use less than schedule 80 pipe where length remaining unthreaded is less than 1 1/2", and where pipe size is less than 1 1/4", and do not thread nipples full length (no close nipples.)
- C. Copper Tube Unions: Provide standard products recommended by the manufacturer for use in the service indicated.
- D. Dielectric/Insulating Unions: Provide standard products recommended by the manufacturer for use in the service indicated, and which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action and stop corrosion.
- E. Welding Materials: Except as otherwise indicated, provide welding materials as determined by the installer to comply with installation requirements. Comply with Section 2-C, ASME Boiler Code for welding materials.
- F. Soldering Materials: Except as otherwise indicated, provide lead free soldering materials as determined by the installer to comply with installation requirements.
- G. Tin-Antimony Solder: ASTM B32, Grade 95YA.
- H. Gaskets for Flanged Joints: ANSI B16.21 full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated.
- I. Gaskets for Grooved Joints: Pressure responsive, ASTM D-2000. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.

2.14 PIPE HANGERS AND SUPPORTS

A. HORIZONTAL PIPING HANGERS AND SUPPORTS:

- 1. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information: size hangers and supports properly for piping including insulation, if any. Minimum hanger spacing shall be in accordance with IPC2009 Table 308.5.
 - a. Adjustable Clevis Hangers: MSS Type 1, fabricated from steel.
 - b. Adjustable Band Hangers: MSS Type 7, fabricated from steel.
 - c. Adjustable Swivel Band Hangers: MSS Type 10.
 - d. Clamp: MSS Type 4.
 - e. Double Bolt Clamp: MSS Type 3, including pipe spacers.
 - f. Adjustable Roller Hangers: MSS Type 43, including axle roller and clevis.
 - g. Steel Brackets: Welded structural steel shapes complying with one of the following:
 - 1) Light Duty: MSS Type 31.
 - 2) Medium Duty: MSS Type 32.

3) Heavy Duty: MSS Type 33.

B. VERTICAL PIPING CLAMPS:

1. General: Except as otherwise indicated, provide factory fabricated vertical piping clamps of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection as determined by the installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size clamps properly for piping, including insulation (if any).
 - a. Two Bolt Riser Clamp: MSS Type 8.
 - b. Four Bolt Riser Clamp: MSS Type 42, including pipe spacers at inner bolt holes.

C. HANGER ROD ATTACHMENTS:

1. General: Except as otherwise indicated, provide factory fabricated hanger rod attachments of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by installer for installation requirements, and comply with MSS AP-69 and the manufacturer's published product information. Size attachments properly for piping, including insulation (if any).
 - a. Turnbuckles: MSS Type 13.
 - b. Weldless Eye Nut: MSS Type 17.
 - c. Malleable Eye Socket: MSS Type 16.
 - d. Clevises: MSS Type 14.

D. BUILDING ATTACHMENTS:

1. General: Except as otherwise indicated, provide factory fabricated building attachments of the MSS type and load rating indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or load rating is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published information. Size units properly for piping loading.
 - a. Concrete Inserts: MSS Type I8, steel.
 - b. Top Beam C-Clamps: MSS Type I9.
 - c. C-Clamps: MSS Type 23, steel
 - d. Top I-Beam Clamp: MSS Type 25.
 - e. Side Beam Clamp: MSS Type 20.
 - f. Beam Clamp/Eye Nut: MSS Type 28.
 - g. Wide Flange Beam Clamp/Eye Nut: MSS Type 29.
 - h. Beam Clamp/Extension Piece: MSS Type 30.

E. SADDLES AND SHIELDS:

1. General: Except as otherwise indicated, provide factory fabricated saddles and shields of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the

manufacturer's published product information. Size saddles and shields properly for insulation and vapor barriers (if any).

- a. Protection Saddles: MSS Type 39.
- b. Protection Shields: MSS Type 40.
- c. Wood Insulation Saddle: Provide products manufactured by Elcen Metal Products Company.

F. MISCELLANEOUS HANGER AND SUPPORT MATERIALS:

1. Metal Framing: Provide products complying with NEMA STD ML 1. Contractor shall provide all miscellaneous steel required for support of work within his contract.
2. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
3. Cement Grout: Portland cement (ASTM C 150, Type I or Type III,) and cleaned uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with only the minimum amount of water required for placement and hydration.
4. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for the loads required, weld steel in accordance with AWS Standards.
5. Pipe Guides: Provide factory fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with two sections guiding spider bolted tightly to the pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of the length recommended by the manufacturer to allow indicated travel.

2.15 VALVES:

- A. General: Provide factory fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

2.16 GATE VALVES:

- A. Packing: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened, and equipped with gland follower. Guides for disc must be machined for accurate fit.
- B. Comply with the following standards:
 1. Cast Iron Valves: MSS SP-70
 2. Bronze Valves: MSS SP-80
 3. For Domestic Water Service Entrance piping:
 - a. Flanged Ends 2-1/2" and Larger: Class 125, iron body bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge.
 4. Manufacturer: Subject to compliance with requirements, provide gate valves of one of the following:

- a. Crane Co., Valve Div.
- b. Milwaukee Valve Co., Inc.
- c. NIBCO, Inc.

C. DRAIN VALVES:

- 1. For Low Pressure Drainage Service:
- 2. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection,
- 3. Soldered Ends 2" and Smaller Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection,
- 4. Manufacturer: Subject to compliance with requirements, provide drain valves of one of the following:
 - a. Crane Co., Valve Div.
 - b. Milwaukee Valve Co. Inc.
 - c. NIBCO, Inc.
 - d. Stockham Valve Co.

D. BALL VALVES:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, provide ball valves of one of the following:
 - a. Conbraco Industries, Inc. (Apollo)
 - b. Crane Co., Valve Div.
 - c. Jamesbury Corp.
 - d. Milwaukee Valve Co., Inc.
 - e. NIBCO, Inc.
 - f. Victaulic Company - Series 726.
- 2. General: Select with full port area, blow-out proof stem, dezincification resistant 2-piece brass/bronze body, hard chrome plated forged brass/bronze ball rated not less than 600# WOG.
- 3. Valves for use in insulated piping systems shall be equipped with 2" extended handles of non-thermal conductive material. A protective sleeve shall allow operation of the valve without disturbing the installation and providing a vapor seal. Product shall be NIBCO NIB-SEAL or approved equal.
- 4. Comply with the following standards: MSS SP-110
- 5. For Domestic Water Service
 - a. Threaded Ends 4" and Smaller: 600# W.O.G., forged bronze 2-piece body, hard chrome plated forged bronze/brass ball, blow-out proof stem.
 - 1) Basis of Design: NIBCO T585-70
 - b. (PressFit): NIBCO PC-585HP-66-LF (2-1/2" to 3")
- 6. For Natural Gas Service
 - a. Threaded Ends 4" and Smaller: 600# W.O.G., Full port, AGA/CSA listed, forged brass/bronze 2-piece body, hard chrome plated forged brass/bronze ball, blow-out proof stem.
 - 1) Basis of Design: Apollo 64 Series

E. BUTTERFLY VALVES:

- 1. General: Comply with MSS SP-67. Where butterfly valves are used as shutoffs for terminal or equipment removal or repair, select lug type valves. Select wafer type valves for other applications. Grooved end butterfly valves shall be used in grooved joint piping systems. Provide gear operation on

butterfly valves 8" and larger. Provide valve bodies with 2" necks where insulation is 2" thick or greater.

F. SWING CHECK VALVES:

1. General: Construct pressure containing parts of valves as follows:
2. Bronze Valves, 125 or 150 psi: ANST/ASTM B62.
3. Comply with MSS SP-71 and MSS SP-SO for design, workmanship, material and testing. Construct valves of pressure casting free of any impregnating materials, Construct valves of bronze, regrinding, with seating angle 40 degrees to 45 degrees, unless composition disc is specified. Provide stop plug as renewable stop for disc hanger, unless otherwise specified. Construct disc and hanger as separate parts, with disc free to rotate. Support hanger pins on both ends by removable side plugs.
4. For Domestic Water Service:
 - a. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, "V" pattern swing, bronze disc.
 - b. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, "V" pattern swing, bronze disc.
 - c. Flanged Ends 2-1/2" and Larger: Class 125, iron body bronze mounted, bolted cap, horizontal swing, cast-iron disc.
 - d. Manufacturer: Subject to compliance with requirements, provide globe valves of one of the following
 - 1) Crane Co., Valve Div.
 - 2) Milwaukee Valve Co., Inc.
 - 3) NIBCO, Inc-
 - 4) Stockham Valves and Fittings, Inc.

G. GLOBE VALVES:

1. Packing: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened, and equipped with gland follower.
2. Composition Discs: Where required, provide suitable material for intended service. For stem throttling service, fit composition disc valve with throttling nut. For metal seated globe valves, provide hardened stainless-steel disc and seat ring.
3. Comply with the following standards:
 - a. Cast-Iron Valves: MSS SP-85.
 - b. Bronze Valves: MSS SP-80.
 - c. For Domestic Water Service:
 - 1) Threaded Ends 2" and Smaller: Class 150, bronze body, union bonnet, rising stem, Teflon disc.
 - 2) Soldered Ends 2" and Smaller: Class 125, bronze body, screwed bonnet, nonrising stem, bronze disc (swivel type).
 - 3) Flanged Ends 2-1/2" and Larger: Class 125, iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc.
 - d. Manufacturer: Subject to compliance with requirements, provide globe valves of one of the following:
 - 1) Crane Co., Valve Div.
 - 2) Milwaukee Valve Co., Inc.
 - 3) NIBCO, Inc.

4) Stockham Valves and Fittings, Inc.

H. VALVE FEATURES:

1. General: Provide valves with features indicated and where not otherwise indicated, provide proper valve features as determined by installer for installation requirements. Comply with ANSI B31.1
2. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
3. Threaded: Valve ends complying with ANSI P2.1.
4. Grooved: Valve ends complying with ANSI/AWWA C606.
5. Solder Joint: Valve ends complying with ANSI P16.18.
6. Trim: Fabricate pressure-containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in the valve manufacturing industry that resists dezincification.
7. Non-Metallic Discs: Non-metallic material selected for service indicated in accordance with the manufacturer's published literature.
8. Renewable Seat: Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn,
9. Extended Stem: Increase stem length by 2" minimum, to accommodate insulation applied over valve.
10. Check Valve: Check valve designed with hinged disc which seals against seat machined in bridgewall of valve body and manufactured for automatic closure by flow reversal.

2.17 LOW PRESSURE Y-TYPE PIPELINE STRAINERS:

- A. General: Comply with FCI 73-1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64" perforations @ 233 per sq. in.
 1. Threaded Ends: 2" and Smaller: Brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with pipe plug.
 2. Threaded Ends: Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with pipe plug.
 3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted pipe plug.
 4. Manufacturer: Subject to compliance with requirements, provide low pressure Y-Type strainers of one of the following:
 - a. Armstrong Machine Works.
 - b. Hoffman Specialty, ITT Fluid Handling Div.
 - c. Metraflex Co.
 - d. Crane Co., Valve Div.
 - e. Milwaukee Valve Co., Inc.
 - f. NIBCO, Inc-

2.18 FLOW CONTROLS

A. Manufacturers:

1. Tyco Flow Control: www.tycoflowcontrol.com.
2. ITT Bell & Gossett: www.bellgossett.com.
3. Griswold Controls: www.griswoldcontrols.com.
4. Taco, Inc: www.taco-hvac.com.
5. Substitutions: See Division 01 - Product Requirements.

B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. PIPING INSTALLATION:

1. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connection, within 1/16" misalignment tolerance.
2. Install all piping in accordance with International Plumbing Code (IPC), International Fuel Gas Code (IFGC), and ANSI B31 Code for Pressure Piping requirements as applicable.

3. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanently enclosed elements of the building; limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
4. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical equipment spaces and enclosures.
5. Piping System Joints: Provide joints of the type indicated in each piping system.
6. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Read threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound/tape on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
7. Install Press Fittings in accordance with manufacturer's installation instructions.
9. Flanged Joints: Match flanged within piping systems, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
10. Insulating Unions: Comply with manufacturer's instructions for installing unions. Install unions in a manner which will prevent galvanic action and stop corrosion when joining ferrous and non-ferrous piping.
11. Grooved Joints: Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to grooved. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the job site and review and installation. Contractor shall remove and replace any joints deemed improperly installed.
12. Unless noted otherwise on the Plumbing drawings all Sanitary/Waste, Kitchen Sanitary/Kitchen Waste, Rainwater, Emergency Rainwater, and Storm piping shall be installed at a minimum continuous 2% slope (1/4" per foot).
13. Unless noted otherwise on the Plumbing drawings all Vent and Condensate Drainage piping shall be installed at a minimum continuous 1% slope (1/8" per foot).
14. Slope all exterior gas piping at a minimum continuous slope of 1/4" per 15 feet and provide condensate drip traps at all low points at accessible location within the conditioned building.

B. PIPING INSPECTION:

1. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings if any. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
2. Disinfect water service piping in accordance with AWWA C601.

C. PIPING TESTS:

1. General: Provide temporary equipment for testing, including pumps and gages. Test piping system before insulation is installed wherever feasible and remove control devices before testing.
2. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
3. Test all non-gas piping systems in accordance with all requirements of IPC Section 312.
 - a. Repair piping systems sections which fail the required piping tests by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.
4. Test all gas piping systems (new and existing piping) as required; 30psi air test with a 24-hour NO LEAK result.
 - a. Repair piping system sections which fail the required piping tests by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.
 - b. Once a passing test is performed this information must be documented and supervised by the Architect/Owner/Engineer and this document must be forwarded to PECO for their records/review.

D. HANGERS AND SUPPORTS:

1. Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building attachments.

E. BUILDING ATTACHMENTS INSTALLATION:

1. Install building attachments at the required locations within concrete or onto structural steel for proper piping support. Space attachments within the maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the top of inserts. Prior to placing concrete, install nut in insert and screw threaded rod thru nut until rod is firmly against top of the insert

body.

F. HANGERS AND SUPPORTS INSTALLATION:

1. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire of perforated metal to support piping, and do not support piping from other piping.
2. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
3. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.
 - a. Do not fasten or anchor work to concrete floor deck except where individually approved by Structural Engineer and Architect.
 - b. Do not fasten or anchor any work directly to metal roof deck.
 - c. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
 - d. Provisions for movement:
 - 1) Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
 - 2) Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3) Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.
 - 4) Insulated Piping: Comply with the following installation requirements:
 - 5) Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 6) Shields: Where low compressive strength insulation of vapor barriers are indicated on cold water piping, install coated protective shields.
 - 7) Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

G. PIPE GUIDE INSTALLATION:

1. Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops.

H. PIPING ANCHORS INSTALLATION:

1. Install anchors at the proper location to prevent stresses from exceeding those permitted by ANSI B31, and to prevent the transfer of loading and stresses to connection equipment.
 - a. Fabricate and install anchor by welding steel shapes, plates and bars to the piping and to the structure. Comply with ANSI B31 and with AWS standards.
 - b. Anchor Spacings: Where not otherwise indicated, install anchors at the ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

I. ADJUSTMENT OF HANGERS AND SUPPORTS:

1. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

J. VALVE INSTALLATION:

1. General: Except as otherwise indicated, comply with the following requirements:
 - a. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
 - b. Install valves with stems pointed up, in the vertical position, where possible, but in no case with stems pointed downward from a horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
 - c. Insulation: Where insulation is indicated, install extended stem valves, arranged in the proper manner to receive insulation.
 - d. Applications Subject to Shock: Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.
 - e. Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless the bronze and steel are separated by a dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.
 - f. OS&Y Valve Stem: Select and install gate valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
 - g. Non-Metallic Disc: Limit the selection and installation of valves with non-metallic discs to locations indicated and where foreign material in the piping system can be expected to prevent tight shut off of metal seated valves.
 - h. Renewable Seats: Select and install valves with renewable seats, except where frequent usage of the valves is indicated.

K. STRAINER INSTALLATION

1. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.
2. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:
 - a. Pumps.
 - b. Temperature control valves.
 - c. Pressure reducing valves.
 - d. Temperature or pressure regulating valves.

3.4 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Provide flow controls in water recirculating systems where indicated.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.
- I. Domestic Water System shall be sanitized and flushed at the end of each phase.

3.6 SERVICE CONNECTIONS

- A. Provide new sanitary and storm sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

3.7 SCHEDULES

- A. Pipe Hanger Spacing: Space hangers in accordance with IPC 2018 Section 308 (inclusive) and Table 308.5.

END OF SECTION 221005

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SECTION 221006 - PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Roof drains.
- B. Floor Drains.
- C. Floor Sinks.
- D. Cleanouts.
- E. Hose bibbs.
- F. Non-Freeze Wall Hydrants.
- G. Backflow preventers.
- H. Plaster Traps.
- I. Thermostatic mixing valves.
- J. Washdown Connection Boxes.
- K. Water hammer arrestors.

1.2 RELATED REQUIREMENTS

- A. Division 01 - Summary: Product requirements for Owner furnished kitchen equipment.
- B. Section 22 0100 - General Provisions
- C. Section 22 1005 - Plumbing Piping.
- D. Section 22 4000 - Plumbing Fixtures.
- E. Section 22 3000 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

- A. ASME A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers; 2001 (R2007).
- B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; The American Society of Mechanical Engineers; 2003.

- C. ASSE 1011 - Hose Connection Vacuum Breakers; American Society of Sanitary Engineering; 2004 (ANSI/ASSE 1011).
- D. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent; American Society of Sanitary Engineering; 2002 (ANSI/ASSE 1012).
- E. ASSE 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type; American Society of Sanitary Engineering; 2004, and Errata 2005 (ANSI/ASSE 1019).
- F. IBC2018 - ICC - International Building Code; 2018
- G. IPC2018 - ICC - International Plumbing Code; 2018
- H. IFGC2018 - ICC - International Fuel Gas Code; 2018
- I. PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute; 2009.

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data for all Piping Specialty specified herein and on the Plumbing Drawings. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each Piping Specialty. Include this data in Maintenance Manual.
- D. Review of submittals which do not clearly indicate the information noted above may be delayed or rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review.
- E. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- F. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.
- G. Operation Data: Indicate frequency of treatment required for interceptors.
- H. Maintenance Data: Include installation instructions, routine maintenance instructions, spare parts lists, exploded assembly views.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 01 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

1.7 EXTRA MATERIALS

- A. See Division 01 - Product Requirements, for additional provisions.
- B. Supply for Owner's use in maintenance of project:
 - 1. Two repair kits including loose key for non-freeze wall hydrants.
 - 2. Two hose end vacuum breakers for hose bibbs.
 - 3. One Lavatory thermostatic mixing valve for every 5 installed units
 - 4. One Water Hammer Arrestor for every 5 installed units of ea. type

PART 2 - PRODUCTS

2.1 DRAINS

- A. Acceptable Manufacturers (for all drainage products):
 - 1. Mifab Drainage Products: www.mifab.com
 - 2. Josam Drainage Products: www.josam.com
 - 3. Jay R. Smith Manufacturing Company: www.jrsmith.com.
 - 4. Zurn Industries, Inc: www.zurn.com.
 - 5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.
- B. Roof Drains (RD-1): Large Area Roof Drains **(ROOF DRAINS WILL BE FURNISHED BY THE PLUMBING CONTRACTOR AND INSTALLED BY THE ROOFING CONTRACTOR)**
 - 1. Refer to Plumbing Drawings for locations and connection sizes
 - 2. Assembly: ASME A112.6.4.
 - 3. Size: 16" diameter
 - 4. Body: Lacquered cast iron with sump.
 - 5. Strainer: Removable cast iron dome with vandal proof screws.
 - 6. Accessories: Coordinate with roofing type.
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Expansion joint (Install only where directed by engineer in field)
 - f. Adjustable non-puncturing extension sleeve for roof insulation.

7. Basis of Design:
 - a. J.R.Smith: Model 1010-Extension-R-C-CID-1710XJ.

C. Condensate Drain (CD-1):

1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, 7" adjustable nickel-bronze strainer with extended anti-splash rim (mount with strainer assembly rim above finished floor elevation to prevent grey water being introduced into condensate drain system.) Provide unit with backwater valve accessory.
 - a. Deep Seal P-trap
2. Refer to drawings for locations and system sizes.
3. Basis of Design:
 - a. J.R. Smith: Model 2005-F37NB-BFV

D. Floor Drain (FD-1) General floor drains in toilet rooms:

1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, 5" diameter adjustable round nickel bronze strainer. Install flush with finished floor.
 - a. Deep seal P-trap
 - b. Pro-Set "trap-guard" sewer gas prevention system in all floor drains.
2. Refer to drawings for locations and system sizes.
3. Basis of Design:
 - a. J.R. Smith: Model 2005 with 5" diameter round grate, drain outlet size shall be as indicated on drawings.

E. Floor Drain (FD-2) Mechanical Room:

1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and twist-to-floor adjustable 8" round ductile iron "safe-set" sediment bucket and grate. Install flush with finished floor.
 - a. Deep Seal P-trap
 - b. Pro-Set "trap-guard" sewer gas prevention system in all floor drains.
2. Refer to drawings for locations and system sizes.
3. Basis of Design:
 - a. J.R. Smith: Model 2350-MBG

F. Floor Drain (FD-3) – Mechanical Room – Deep Sump (Boilers, Blowdown):

1. ASME A112.6.3; Deep body, lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and adjustable ductile iron "safe-set" sediment bucket and grate. Install flush with finished floor.
 - a. Deep Seal P-trap
 - b. Pro-Set "trap-guard" sewer gas prevention system in all floor drains.
2. Refer to drawings for locations and system sizes.
3. Basis of Design:
 - a. J.R. Smith: Model 2240 Series.

G. Floor Sink (FS-1) - Kitchen Drain:

1. 12 in. square, 14 ga. 304SS receiver, cast 316SS ribbed non-tilt loose set grate with 1/2 inch square holes, seepage control holes, perforated SS dome bottom strainer.
 - a. Provide Pro-Set "trap-guard" sewer gas prevention system. Verify if Owner wants to install Trap-Guard in floor sink prior to installation.
2. Refer to drawings for locations and system sizes.
3. Depth: 10 inches.
4. Flashing Clamp: (Verify clamp to rim dimension with floor construction prior to order).
5. Grate Style: Half Grate. Open portion of grate shall be toward the wall side (rear) of the floor sink.
6. Install as indirect waste receptor with rim above finished floor if required by the AHJ. Verify all requirements with AHJ prior to installation.
7. Basis of Design:
 - a. J.R. Smith: Model 9694-12.

H. Floor Sink (FS-2) - General Indirect Small Equipment Drain:

1. 12 in. square, 14 ga. 304SS receiver, cast 316SS ribbed non-tilt loose set grate with 1/2 inch square holes, seepage control holes, perforated SS dome bottom strainer
 - a. Deep Seal P-trap
 - b. Pro-Set "trap-guard" sewer gas prevention system. Verify if Owner wants to install Trap-Guard in floor sink prior to installation.
2. Refer to Floor plans for connection sizes.
3. Depth: 4 inches
4. Flashing Clamp (Verify clamp to rim dimension with floor construction prior to order)
5. Grate Style: Half Grate. Open portion of grate shall be toward the wall side (rear) of the floor sink.
6. Install as indirect waste receptor with rim above finished floor if required by the AHJ. Verify all requirements with AHJ prior to installation.
7. Basis of Design:
 - a. J.R. Smith: Model 9691-12.

2.2 CLEANOUTS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Zurn Industries, Inc: www.zurn.com.
4. Mifab Drainage Products: www.zurn.com.
5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Cleanouts at Exterior Areas (CTG):

1. Cast Iron Cleanout and double flanged housing, Round cast iron scoriated non-skid cover with lifting device, cleanout ferrule w/ABS closure plug. Provide 4" thick concrete pad around cleanout cover.
2. Refer to plans for locations and details of installation.
3. Basis of Design:
 - a. J.R. Smith: Model 4261

C. Cleanouts at Interior Finished Floor Areas (FCO):

1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, PVC plug, and round gasketed scoriated cover in ALL areas, and carpet marker on units installed in carpeted areas (see documents for additional information).
2. Basis of Design:
 - a. J.R. Smith: Model 4100 series with top finish as required by final floor finish

D. Cleanouts at Interior Finished Wall Areas:

1. Provide Sanitary-T and extension to finish wall construction with Cleanout ferrule, threaded plug and cover. Refer to Plumbing Details for additional information.
2. Cover
 - (a) Finished Tile walls - Provide w/stainless steel cover.
 - (b) Finished painted walls - Provide with prime coated paintable steel cover.

E. Cleanouts at Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.3 HOSE BIBBS (HB)

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jrsmith.com.
2. Woodford: www.woodfordmfg.com
3. Watts Regulator Company: www.watts.com.
4. Zurn Industries, Inc: www.zurn.com.
5. Mifab Drainage Products: mifab.com
6. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Interior Hose Bibbs (HB-1):

1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with handwheel, integral vacuum breaker in conformance with ASSE 1011.
2. Basis of Design:
 - a. Woodford model 101C with 1/2" sweat fitting inlet, 3/4" male hose thread outlet connection, integral atmospheric vent and patented check, and adjustable polycarbonate wall flange.

2.4 NON-FREEZE WALL HYDRANT (NFWH)

A. Manufacturers:

1. Josam Company: www.josam.com; Model compatible model to specified unit below.
2. Jay R. Smith Manufacturing Company: www.jrsmith.com.
3. Zurn Industries, Inc; Model compatible model to specified unit below: www.zurn.com.
4. Mifab Drainage Products; Model compatible model to specified unit below: www.mifab.com
5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Non-Freeze Wall Hydrants (NFWH-1):

1. ASSE 1019; freeze resistant, box type, self-draining type with polished bronze wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker and dual check valve.
2. Basis of Design:
 - a. Jay R. Smith Guardian Dual Check: Model 5519-WC-CL-NB

2.5 WASHDOWN CONNECTION BOX (WB) – GANG TOILET ROOMS

A. Box Manufacturers:

1. Acorn Engineering: www.acorneng.com
2. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Washdown Connection Box (WB-1)

1. 304SS box, removable door with cylinder lock, 3/4-in. Cold connection, 3/4" NPSH hose thread outlet connection, and integral vacuum breaker, removable loose key wheel handle cartridge operated valves w/ screwdriver stops.
2. Basis of Design:
 - a. Acorn Engineering: Model 8151

2.6 BACKFLOW PREVENTERS

A. Manufacturers:

1. Ames Co. Fluid Control Systems: www.amesfirewater.com
2. Conbraco Industries: www.conbraco.com.
3. Watts Regulator Company: www.wattsregulator.com.
4. Wilkins/Zurn Industries, Inc: www.zurn.com.
5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Reduced Pressure Zone Backflow Preventers (3/4"-2"):

1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two quarter turn ball valves, strainer, air gap fitting, four test cocks and in-line strainer.
 - a. Watts Model 909-QT-S (3/4"-1") w/series 909AG air gap fitting
 - b. Watts Model 909-M1-QT-S (1 1/4"-2") w/series 909AG air gap fitting

2.7 PLASTER TRAPS (PT)

A. Construction:

1. Manufacturers:
 - a. Schier Products: www.schierproducts.com
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.
2. Material: Rotationally molded High-Density Polyethylene
3. Rough-in: Below sink "in-lieu" of p-trap.
4. Accessories: 1-1/2-inch & 2-inch inlet/outlet connections, removable sediment bucket with filter screen. Contractor shall install unit with unions/ferenco couplings on inlet and outlet of unit to enable easy removal for maintenance.
5. Cover: Top access gasketed secured cover, stainless-steel draw latches and hardware with an ABS handle for easy removal of sediment bucket.
6. Refer to floor plans for location of unit and specifics.
7. Basis of Design: PT-1: Schier Products model USI-1180-1 Solid Interceptor.
8. Basis of Design: PT-2: Schier Products model USI-1180-2 Solid Interceptor.

2.8 THERMOSTATIC MIXING VALVES

B. Thermostatic Mixing Valves:

1. Manufacturers:
 - a. Powers Valves: T/P with Paraffin actuator.
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.
2. Valve: Solid brass construction, corrosion resistant internal components, adjustable temperature selection with locknut to prevent tampering, integral checks with screens.

B. Lavatory Mixing Valves:

1. Temperature and pressure regulating Under-the-Counter combination tempering valves for temperature control to ASSE 1070 down to 0.5gpm.
 - a. Powers Series e480 must be rated for minimum flow of 0.5 gpm.

C. Mixing Valves for Larger Flow Capacities and Domestic Water Heaters (MMV-1):

1. Single Hi-Lo Thermostatic tempering valve w/paraffin actuator for temperature control to ASSE 1017.
 - a. Powers Series LFSH1432-1-1.

D. Emergency Eyewash/Facewash Mixing Valves:

1. Advanced thermal actuators, internal cold water bypass (ensures cold water flow in the event of loss of hot water), meets ASSE 1071, vandal-resistant locking mechanism to secure temperature setting, factory tested, union triple-duty checkstops, rough bronze, temperature/pressure gauge on outlet.
 - a. Powers HydroGuard XP Series Emergency Tempering Valve with Cold Water Bypass: Model ES-150-11

2.9 WATER HAMMER ARRESTORS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jrsmith.com.
2. Sioux Chief: www.siouxchief.com.
3. Zurn Industries, Inc: www.zurn.com.
4. Mifab Drainage Products: www.mifab.com
5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Water Hammer Arrestors:

1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201 and per drawings, pre-charged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all piping specialties in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil or Teflon tape. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade at all locations where sanitary or storm piping exits the building footprint.
- D. Install floor cleanouts at elevation to accommodate finished floor.

- E. Install approved portable water protection devices on plumbing lines as indicated on drawings and where contamination of domestic water may occur; including boiler makeup water lines, chemical mixers within janitor rooms, fire sprinkler systems, irrigation systems, flush valves, interior and exterior hose bibbs. Additional backflow prevention is not required when the connected equipment is provided with integral backflow prevention in accordance with the International Plumbing Code and the equipment is permanently/directly connected to the water supply.
- F. Pipe relief from backflow preventers with air gap drain fitting to nearest adequately sized floor drain or building exterior.
- G. Provide pressure gauges on inlet and outlet of all pressure reducing valves, backflow preventer assemblies.
- H. Install water hammer arrestors complete with accessible isolation valve on water supply piping to urinal/water closet flush valves and automatic washer connections.
- I. Install floor drains at existing domestic water service and new fire protection service entrance piping/valving. Coordinate location of floor drain prior to rough in.

END OF SECTION 221006

SECTION 221116 - DOMESTIC WATER PIPING (PEX-A)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Potable hot and cold water distribution system, using crosslinked polyethylene (PEX) tubing and ASTM F1960 cold expansion fittings.

- 1. PEX-a tubing only pertains to pipe sizes 2-inch and smaller.

1.2 RELATED REQUIREMENTS

- A. Division 07 - Firestopping
- B. Division 09 - Access Doors and Panels
- C. Division 09 - Painting
- D. Division 31 - Excavation, Fill and Trenching
- E. Section 220502 - Excavation, Backfill and Compaction of Utilities
- F. Section 220553 - Identification for Plumbing Piping and Equipment.
- G. Section 220719 - Plumbing Piping Insulation.
- H. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.
- I. Section 220800 - Plumbing System Commissioning
- J. Section 221006 - Plumbing Piping Specialties

1.3 REFERENCE STANDARDS

- A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
- B. ASTM International
 - 1. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - 2. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials

3. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops
4. ASTM F876 Standard Specification for Cross-linked Polyethylene (PEX) Tubing
5. ASTM F877 Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
6. ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing

C. American National Standards Institute (ANSI)/National Sanitation Foundation (NSF)

1. ANSI/NSF Standard 14 Plastics Piping System Components and Related Materials
2. ANSI/NSF Standard 61 Drinking Water System Components - Health Effects

D. American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL)

1. ANSI/UL 263 Standard for Safety for Fire Tests of Building Construction and Materials

E. International Code Council (ICC)

1. International Plumbing Code (IPC-2018)
2. ICC Evaluation Service (ES) Evaluation Report No. ESR 1099

F. International Association of Plumbing Officials (IAPMO)

1. Uniform Plumbing Code (UPC)

G. National Association of Plumbing, Heating and Cooling Contractors (NAPHCC)

1. National Standard Plumbing Code (NSPC)

H. Plastics Pipe Institute (PPI)

1. PPI Technical Report TR-4/06

I. Uponor, Inc.

1. Uponor Professional Plumbing Installation Guide, Latest Update

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Standard grade hydrostatic pressure ratings from Plastics Pipe Institute (PPI) in accordance with TR-3 as listed in TR-4. The following three standard-grade hydrostatic ratings are required.

- a. 200°F (93°C) at 80 psi (551 kPa)
 - b. 180°F (82°C) at 100 psi (689 kPa)
 - c. 73.4°F (23°C) at 160 psi (1,102 kPa)
2. All PEX tubing (1/2" thru 2") shall be installed with Uponor PEX-a Pipe Support with a maximum distance of 10" between pipe support pieces. PEX-a Pipe Support shall terminate a maximum of 5" away from the centerline of the adjacent fitting. All PEX-a tubing provided on the project shall be insulated as follows:
- a. GLASS FIBER
 1. Manufacturers:
 - a. Knauf Fiber Glass: www.knaufusa.com.
 - b. Johns Manville Corporation: www.jm.com
 - c. Owens Corning Corp: www.owenscorning.com
 - d. Certain Teed Corporation: www.certainteed.com.
 - e. Substitutions: Refer to Division 01
 2. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible, all service jacket.
 - a. 'K' value" ASTM C 177, 0.24 at 75 degrees F.
 - b. Maximum service temperature: 850 degrees F.
 - c. Maximum moisture absorption: 0.2 percent by volume.
 3. Insulation: ASTM C547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
 - a. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
 - b. Maximum service temperature: 650 degrees F.
 - c. Maximum moisture absorption: 0.2 percent by volume.
 4. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.
 5. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
 6. Vapor Barrier Lap Adhesive:
 - a. Compatible with insulation.
 7. Insulating Cement/Mastic:
 - a. ASTM C 195; hydraulic setting on mineral wool.
 - b. INSULATION SCHEDULES
 1. Domestic Cold Water:
 - a. Glass Fiber Insulation (All-Service Jacket):
 - 1) Pipe Size Range:
 - (a) up to and including 2-inch: 1-inch thick
 2. Domestic Hot Water Recirculation:
 - a. Glass Fiber Insulation (All-Service Jacket):
 - 1) Pipe Size Range:
 - (a) up to and including 1-inch: 1-inch thick
 - (b) 1-1/4-inch and larger: 1-1/2-inch thick
 3. Domestic Hot Water Supply:
 - a. Glass Fiber Insulation (All-Service Jacket):
 - 1) Pipe Size Range:
 - (a) up to and including 1-inch: 1-inch thick
 - (b) 1-1/4-inch and larger: 1-1/2-inch thick

4. Tempered Domestic Water Supply:
 - a. Glass Fiber Insulation (All-Service Jacket):
 - 1) Pipe Size Range:
 - (a) all sizes: 1-inch thick
- B. Performance Requirements: To provide a PEX tubing hot and cold potable water distribution system, which is manufactured, fabricated and installed to comply with regulatory agencies and to maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.
1. Comply with ANSI/NSF Standard 14.
 2. Comply with ANSI/NSF Standard 61.
 3. Show compliance with ASTM F877.
 4. Show compliance with ASTM E119 and ANSI/UL 263 through certification listings with Underwriters Laboratories, Inc. (UL).
 - a. UL Design No. L557 — 1 hour wood frame floor/ceiling assemblies
 - b. UL Design No. K913 — 2 hour concrete floor/ceiling assemblies
 - c. UL Design No. U372 — 1 hour wood stud/gypsum wallboard wall assemblies
 - d. UL Design No. V444 — 1 hour steel stud/gypsum wallboard wall assemblies

1.4 SUBMITTALS

- A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
- B. Product Data: Submit manufacturer's product submittal data and installation instructions.
- C. Samples: Submit selection and verification samples of tubing.
- D. Quality Assurance/Control Submittals: Submit the following:
 1. Test Reports: Upon request, submit test reports from recognized testing laboratories.
 2. Certificates: Submit the following:
 - a. Manufacturer's certificate that products comply with specified requirements.
 - b. Certificate indicating that the installer is authorized to install the manufacturer's products
- E. Closeout Submittals: Submit the following:
 1. Warranty documents specified herein
 2. Operation and maintenance data

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Use an installer with demonstrated experience on projects of similar size and complexity and possessing documentation proving successful completion of PEX plumbing installation training by the PEX tubing manufacturer.

B. Regulatory Requirements and Approvals: Provide domestic potable system that complies with requirements of the following:

1. International Code Conference (ICC) – International Plumbing Code (IPC)
 - a. ICC Evaluation Service (ES) Evaluation Report No. ESR 1099
2. Uniform Plumbing Code (UPC)
 - a. IAPMO Files 3558, 3946 and 3960
3. National Standard Plumbing Code (NSPC)

C. Certifications: Provide letters of certification as follows:

1. Installer is trained by the PEX tubing manufacturer to install the PEX potable water distribution system.
2. Installer will use skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed trades professional.

1.6 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with Division 1 Product Requirement Section.
- B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
 1. Store PEX tubing in cartons or under cover to avoid dirt or foreign material from being introduced into the tubing.
 2. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of tubing exposed to direct sunlight.

1.7 WARRANTY

- A. Uponor offers a limited warranty of up to 25 years for its Wirsbo AQUAPEX® tubing and ProPEX® Fittings when installed by an Uponor-trained contractor and certified plumbing professional. See www.uponor-usa.com for details in the Customer Service section.

PART 2 - PRODUCTS

2.1 HOT AND COLD DOMESTIC WATER DISTRIBUTION SYSTEM

A. Manufacturer: Uponor

1. Contact: 5925 148th Street West, Apple Valley, MN 55124; Toll free (800) 321-4739, (952) 891-2000; Fax: (952) 891-2008; website: www.uponor-usa.com
 - a. [Local Representative / Rich-Tompkins](#)

2.2 MATERIALS

A. Tubing

1. Material: Crosslinked polyethylene (PEX) manufactured by PEX-a or Engel method
2. Type: Wirsbo AQUAPEX
3. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency
4. Standard grade hydrostatic design and pressure ratings from PPI
5. Fire-rated assembly listings in accordance with ANSI/UL 263
 - a. UL Design No. L557 — 1-hour wood frame floor/ceiling assemblies
 - b. UL Design No. K913 — 2-hour concrete floor/ceiling assemblies
 - c. UL Design No. U372 — 1-hour wood stud/gypsum wallboard wall assemblies
 - d. UL Design No. V444 — 1-hour steel stud/gypsum wallboard wall assemblies
6. Minimum Bend Radius (cold bending): No less than six times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.
 - a. Uponor Metal Bend Support #A5110xxx
 - b. Uponor Plastic Bend Support #A5xxxxxx
7. Nominal Inside Diameter: Provide tubing with nominal inside diameter, in accordance with ASTM F876 as indicated.
 - a. $\frac{3}{8}$ inch [9.53mm]
 - b. $\frac{1}{2}$ inch [12.7mm]
 - c. $\frac{3}{4}$ inch [19.05mm]
 - d. 1 inch [25.4mm]
 - e. $1\frac{1}{4}$ inch [31.75mm]
 - f. $1\frac{1}{2}$ inch [38.1mm]
 - g. 2 inch [50.8mm]

B. Fittings

1. Material: Fitting assembly is manufactured from material listed in paragraph 5.1 of ASTM F1960.
2. Material Standard: Comply with ASTM F1960.
3. Expansion Fitting: PEX-a cold expansion fitting.
 - a. Assembly consists of the appropriate ProPEX insert with a corresponding ProPEX Ring.

- b. Install on all domestic hot, return and cold water piping every 50 feet (max.) of straight-length horizontal piping.
- c. Refer to manufacturer's Expansion Joint Installation and Data Sheets for necessary spacing, support, anchors, guides, etc.

C. Manifolds

- 1. Material
 - a. Type L copper body with UNS 3600 series brass ProPEX outlet connections
 - b. Engineered Plastic (EP) body with ProPEX outlet connections
- 2. Manifold Type
 - a. Uponor Pro PEX 1" Copper Manifold
 - b. Uponor engineered plastic (EP) Manifold
- 3. All manifolds manufactured with the appropriate-sized ProPEX fittings on the manifold supply inlets.

D. Accessories

- 1. Angle stops and straight stops that are compatible with PEX tubing are supplied by the PEX tubing manufacturer.
- 2. Bend supports designed for maintaining tight radius bends are supplied by the PEX tubing manufacturer.
- 3. ProPEX expander tool to install the ASTM F1960 compatible fittings are supplied by the PEX tubing manufacturer.
- 4. The tubing manufacturer provides clips and/or PEX rails for supporting tubing runs.
- 5. All horizontal tubing hangers and riser clamps are epoxy-coated material.
- 6. Provide pipe hangers and supports in accordance with specifications, PEX-A pipe manufacturers recommendations, IPC, All local codes, Authorities having Jurisdiction, etc.
- 7. Straight-Through support: Uponor # F5140500
- 8. Plastic Drop Ear Bend Support: Uponor #F5200xxx
- 9. PEX Wall Support Bracket: Uponor #A5750500
- 10. Metal Drop Ear Bend Support: Uponor #F5120xxx
- 11. PEX-A Pipe Support: Uponor #F704xxxx
- 12. PEX-A Pipe Support: Uponor #F704xxxx
 - a. Non-combustible, self-gripping, galvanized steel channel. Provides continuous, uninterrupted support of PEX-A pipe, allowing hanger placement similar to that of metallic pipe. Pipe Supports **MUST** be used on all PEX-A pipe installations.
 - b. Install on all vertical and horizontal piping.
 - c. Refer to the Uponor PEX-A Pipe Support Instruction Sheet for installation guidelines.

PART 3 – EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- A. Comply with manufacturer's product data, including product technical bulletins, installation instructions, design drawings and the Uponor Professional Plumbing Installation Guide.

3.2 EXAMINATION

- A. Site Verification of Conditions:
 - 1. Verify that site conditions are acceptable for installation of the PEX potable water system.
 - 2. Do not proceed with installation of the PEX potable water system until unacceptable conditions are corrected.

3.3 INSTALLATION

- A. Uponor AQUAPEX Tubing
 - 1. Install Wirsbo AQUAPEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.
 - 2. Do not install PEX tubing within 6 inches [152 mm] of gas appliance vents or within 12 inches [305 mm] of any recessed light fixtures.
 - 3. Do not solder within 18 inches [457 mm] of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
 - 4. Do not expose PEX tubing to direct sunlight for more than 30 days.
 - 5. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
 - 6. Use grommets or sleeves at the penetration for PEX tubing passing through metal studs.
 - 7. Protect PEX tubing with sleeves where abrasion may occur.
 - 8. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.
 - 9. Use tubing manufacturer-supplied bend supports where bends are less than six times the outside tubing diameter.
 - 10. Minimum horizontal supports are installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.
 - 11. PEX riser installations require epoxy-coated riser clamps installed at the base of the ceiling per floor.
 - 12. A mid-story support is required for riser applications.
 - 13. Pressurize Wirsbo AQUAPEX tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi (173 kPa) above normal working pressure of the system.
 - 14. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32°F (0°C).

B. Through-penetration Firestop

1. Ensure compliance of one- and two-hour rated through penetration assemblies in accordance with ASTM E814.
2. A list of firestop manufacturers that list PEX tubing with their firestop systems is available from the PEX tubing manufacturer.

C. Related Products Installation: Refer to other sections listed in Related Sections paragraph herein for related products installation.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide manufacturer's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

1. Site Visits: Minimum of (3) 6 hour site visits.

3.5 CLEANING

- A. Remove temporary coverings and protection of adjacent work areas.
- B. Repair or replace damaged installed products.
- C. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.
- D. Remove construction debris from project site and legally dispose of debris.

3.6 SLEEVES

- A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.
- B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal.
- C. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.

- D. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material.

3.7 VALVES:

- A. All valves shall be lead free
- B. Provide factory fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.
- C. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as determined by installer for installation requirements. Comply with ANSI B31.1

D. BALL VALVES:

1. Provide Lead Free Ball Valves
2. Select with full port area, blow-out proof stem, dezincification resistant 2-piece brass/bronze body, hard chrome plated forged brass/bronze ball rated not less than 600# WOG.
3. Valves for use in insulated piping systems shall be equipped with 2" extended handles of non-thermal conductive material. A protective sleeve shall allow operation of the valve without disturbing the installation and providing a vapor seal. Product shall be NIBCO NIB-SEAL or approved equal.
4. Comply with the following standards: MSS SP-110
5. Acceptable Manufacturers: Subject to compliance with requirements, provide ball valves of one of the following:
 - a. NIBCO, Inc. www.nibco.com
 - b. Watts, Inc. www.watts.com
 - c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.
6. Domestic Water Service:
 - a. Threaded Ends 4" and Smaller: 600# W.O.G., forged bronze 2 piece body, hard chrome plated forged bronze/brass ball, blow-out proof stem.
 - 1) Basis of Design: NIBCO T685
 - b. Press-Fit 3" and Smaller: 600# W.O.G., forged bronze 2 piece body, hard chrome plated forged bronze/brass ball, blow-out proof stem.
 - 1) Basis of Design: NIBCO
 - c. PEX Ends 2-inch and smaller: 250 CWP, lead-free brass body and ball, blow-out proof stem
 - 1) Basis of Design: Uponor LF Commercial Ball Valve LFC482XXXX

E. CHECK VALVES:

1. Check valve designed with hinged disc which seals against seat machined in bridgewall of valve body and manufactured for automatic closure by flow reversal.

2. Flanged:
 - a. Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI P16.24 (bronze).
3. Non-Metallic Discs:
 - a. Non-metallic material selected for service indicated in accordance with the manufacturer's published literature
4. Renewable Seat:
 - a. Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.
5. Solder Joint:
 - a. Valve ends complying with ANSI P16.18
6. Threaded:
 - a. Valve ends complying with ANSI P2.1
7. Trim:
 - a. Fabricate pressure-containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in the valve manufacturing industry that resists dezincification.

F. CIRCUIT SETTER VALVES:

1. Construct pressure containing parts of valves as follows:
 - a. Lead free construction
 - b. Dezincification resistant Brass, minimum pressure rating of 300psi @ 200F
 - c. Comply with ANSI B1.20.1 (NPT ends), ANSI B16.18 (soldered ends)
2. Manufacturer: Subject to compliance with requirements, provide valves of one of the following
 - a. NIBCO, Inc. www.nibco.com
 - b. Bell & Gossett, Inc www.xyleminc.com
 - c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
3. Domestic Hot Water Recirculation Service:
 - a. Soldered Ends:
 - 1) 2" and Smaller: Nibco Series S1710/T1710L
 - b. Threaded Ends
 - 1) 2" and Smaller: Nibco Series T1710/T1710L

G. DRAIN VALVES:

1. For Low Pressure Drainage Service:
2. Soldered Ends:
 - a. 2" and Smaller Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection.
3. Threaded Ends:
 - a. 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection,

4. Manufacturer: Subject to compliance with requirements, provide drain valves of one of the following:
 - a. NIBCO, Inc. www.nibco.com
 - b. Watts, Inc. www.watts.com
 - c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.

H. SWING CHECK VALVES:

1. Construct pressure containing parts of valves as follows:
 - a. Bronze Valves, 125 or 150 psi: ANST/ASTM B62.
 - b. Comply with MSS SP-71 and MSS SP-SO for design, workmanship, material and testing. Construct valves of pressure casting free of any impregnating materials, Construct valves of bronze, regrinding, with seating angle 40 degrees to 45 degrees, unless composition disc is specified. Provide stop plug as renewable stop for disc hanger, unless otherwise specified. Construct disc and hanger as separate parts, with disc free to rotate. Support hanger pins on both ends by removable side plugs.
2. Manufacturer: Subject to compliance with requirements, provide valves of one of the following
 - a. NIBCO, Inc. www.nibco.com
 - b. Watts, Inc. www.watts.com
 - c. Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

3.8 INSTALLATION

A. ALIGNMENT:

1. Where several valves, piping, devices, equipment, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.
2. The Mechanical and Electrical Contractors shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

B. BUILDING ATTACHMENTS INSTALLATION:

1. Install building attachments at the required locations onto structural steel for proper piping support. Space attachments within the maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.

Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the top of inserts. Prior to placing concrete, install nut in insert and screw threaded rod thru nut until rod is firmly against top of the insert body.

C. ESCUTCHEONS:

1. All exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces, shall be provided with solid pattern heavy ceiling, floor or wall escutcheons with set screw. Escutcheons and plates shall be of steel or malleable iron with prime coat ready for painting. Escutcheons will not be provided where sleeves intentionally extend above finished floor.
2. All exposed plumbing short branch connections to fixtures and/or equipment passing through wall or floors shall be equipped with pressed brass, chromium plated, solid-type escutcheons.
3. Provide angle collars at ducts where they pass through finished walls, floors and ceilings.

D. PIPING ANCHORS INSTALLATION:

1. Install anchors at the proper location to prevent stresses from exceeding those permitted by ANSI B31, and to prevent the transfer of loading and stresses to connection equipment.
 - a. Fabricate and install anchor by welding steel shapes, plates and bars to the piping and to the structure. Comply with ANSI B31 and with AWS standards.
 - b. Anchor Spacing's: Where not otherwise indicated, install anchors at the ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

E. PIPE GUIDE INSTALLATION:

1. Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops.

F. PIPING HANGERS & SUPPORTS:

1. Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building attachments.
2. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire of perforated metal to support piping, and do not support piping from other piping.

3. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
4. Prime coat exposed steel hangers and supports. Refer to Division 09 - Painting Hanger and supports located in crawl spaces, pipe shafts and suspended ceiling spaces are not considered exposed.
5. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22054
6. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
7. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.
 - a. Do not fasten or anchor work to concrete floor deck except where individually approved by Structural Engineer and Architect.
 - b. Do not fasten or anchor any work directly to metal roof deck.
 - c. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
 - d. Provisions for movement:
 - 1) Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
 - 2) Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 4) Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 5) Shields: Where low compressive strength insulation of vapor barriers are indicated on cold water piping, install coated protective shields.
 - 6) Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

G. ADJUSTMENT OF HANGERS AND SUPPORTS:

1. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

H. PIPING INSPECTION:

1. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings if any. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

I. PIPING INSTALLATION:

1. Install all piping in accordance with International Plumbing Code (IPC), and ANSI B31 Code for Pressure Piping requirements as applicable.
2. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leak-proof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connection, within 1/16" misalignment tolerance.
3. Provide Nail Plat at Floor line where all PEX-a piping penetrates floor slab.
4. Install all piping in accordance with International Plumbing Code (IPC) and ANSI B31 Code for Pressure Piping requirements as applicable.
5. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanently enclosed elements of the building; limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
6. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical equipment spaces and enclosures.
7. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
8. Install piping to maintain headroom, conserve space, and not interfere with use of space.
9. Group piping whenever practical at common elevations.
10. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 220719
11. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 - Access Doors and Panels
12. Sleeve all piping that passes through partitions, walls and floors.

J. PIPING TESTS:

1. General: Provide temporary equipment for testing, including pumps and gages. Test piping system before insulation is installed wherever feasible and removes control devices before testing.

2. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
3. Test all non-gas piping systems in accordance with all requirements of IPC Section 312.
 - a. Repair piping systems sections which fail the required piping tests by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.

K. PIPE GUIDE INSTALLATION:

1. Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops.

L. VALVE INSTALLATION:

1. General: Except as otherwise indicated, comply with the following requirements:
 - a. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
 - b. Install valves with stems pointed up, in the vertical position, where possible, but in no case with stems pointed downward from a horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
 - c. Insulation: Where insulation is indicated, install extended stem valves, arranged in the proper manner to receive insulation.
 - d. Applications Subject to Shock: Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.
 - e. Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless the bronze and steel are separated by a dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.
 - f. Non-Metallic Disc: Limit the selection and installation of valves with non-metallic discs to locations indicated and where foreign material in the piping system can be expected to prevent tight shut off of metal seated valves.
 - g. Renewable Seats: Select and install valves with renewable seats, except where frequent usage of the valves is indicated.

3.9 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of system or vertical risers.

- C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Provide flow controls in water recirculating systems where indicated.

3.10 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean. Sanitize and flush domestic water system after each phase.
- B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.11 PROTECTION

- A. Protect installed work from damage due to subsequent construction activity on the site.

END OF SECTION 221116

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SECTION 223000 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Domestic Hot Water Circulators
- B. Grease Interceptors.
- C. Instantaneous Water Heaters

1.2 SUBMITTALS

- A. Product Data:
 - 1. Indicate pump type, capacity, power requirements.
 - 2. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 3. Provide electrical characteristics and connection requirements.
- B. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer. Warranty shall begin after final payment.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.5 EXTRA MATERIALS

- A. See Division 01 - Project Requirements, for additional provisions.

1.6 OWNER INSTRUCTION/DEMONSTRATION

- A. Provide owner instruction and demonstration for all pieces of installed equipment. Demonstration shall include: regular operating instructions, required regular maintenance, regular required maintenance schedule for each piece of equipment. P.C. shall employ the service of a manufacturer's representative where necessary or where otherwise noted in these specifications.

PART 2 PRODUCTS

2.1 IN-LINE CIRCULATOR PUMPS

A. Manufacturers:

1. Grundfos
2. Armstrong
3. Taco
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.
5. Refer to Detail on Plumbing Drawings for pump size, accessories, and requirements.

2.2 GREASE INTERCEPTOR

A. Manufacturers:

1. Schier
2. Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. Kitchen Grease Interceptor (GI-1):

1. Description: Seamless, rotationally molded high-density polyethylene tank with minimum 3/8 inch uniform wall thickness. Interceptor shall be engineered for above or below grade installation. Interceptor shall be built in accordance to ASME A112.14.3 (type C) with field adjustable riser system, and built in flow control. Interceptor grease capacity shall be at least four times its rated flow (GPM). Cover shall provide water/gas tight seal and have minimum H20/HS20 load capacity.
2. Capacity:
 - a. Flow: 100 GPM
 - b. Grease capacity: 1,751 lbs.
 - c. Solids: 21 gallons.

- d. Liquid: 275 gallons.
- 3. Grease interceptor shall have third party certification to ASME grease interceptor standard #A112.14.3
- 4. Interceptor shall be supplied with built in adaptor for up to 6" lid riser adjustability. Additional risers shall be available for deeper burial depths (Contractor shall verify exact requirements in field).
- 5. Interceptor cover placement shall provide full access to tank for proper maintenance.
- 6. Interceptor shall have integral air relief/anti-siphon.
- 7. Interceptor shall be equipped with 4" no-hub connections for inlet and outlet.
- 8. Lifetime warranty: Interceptor shall be lifetime guaranteed and Made in USA.
- 9. H2O rated relieving pad – Site Contractor shall provide H2O concrete relieving pad. Refer to Plumbing drawings and manufacturers details for design and minimum dimensions of relieving pad. Relieving pad shall be sloped to prevent ponding of water on relieving pad and at access covers. P.C. shall coordinate all pad details/grades with site construction in field, prior to beginning any work.
- 10. Anchor Kit - All interceptors installed below grade shall be provided with ant-flotation anchor kit where water table can exceed lowest level of installation.
- 11. Basis of Design: Schier Products Great Basin GB-250 - 100 GPM, 275 liquid gallons, 1,751 lbs. grease capacity.

2.4 INSTANTANEOUS POINT-OF-USE WATER HEATERS

A. Manufacturers

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - a. Eemax; www.eemax.com.
 - b. Chronomite Laboratories Inc.

B. Description: Point-of-use, tankless, electric water heater conforming to applicable requirements of UL 499. Refer to plumbing drawings for locations.

C. Construction: Manufacturer's standard and without hot-water storage.

D. Working-Pressure Rating: 150 psig (1035 kPa).

E. Electric Heating System: Nickel chrome electric-resistance type.

F. Cover: UL rated 94 Vo.

G. Mounting: Bracket or device for wall mounting.

H. Temperature Control: Factory pre-set, temperature-control thermostat for adjustable, outlet-water temperature (Coordinate temperature setting with the owner).

I. Safety Control: Automatic, high-temperature-limit cutoff.

J. Schedule

1. IWH-1 (Triple Bowl Sink)
 - a. Basis of Design: Eemax model: EX180T2T, 18 KW, 208 volts, 3 phase, 50 amps, 0.7 GPM turn-on, 32 degrees Fahrenheit temperature rise at 4.0 gpm.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related electrical work for each piece of equipment to achieve operating system.
- C. Recirculation Pumps:
 1. Refer to Detail on Plumbing Drawings for pump installation information and associated piping accessories.
 2. Provide circuit setter valve set to specified flow.
 3. Install circulation pumps in orientation as required by manufacturers recommendations.
 4. Coordinate power wiring to pump and aqua stat controls with E.C. in field.
 5. Set programmable timer as directed by Owners Maintenance representative.
- D. Grease Interceptor
 1. Install grease interceptor in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification.
 2. Provide venting of downstream piping as required by local Authority Having Jurisdiction.
 3. Exterior Installations (Below Grade):
 - a. Verify inverts for all below grade/below slab grease interceptors prior to beginning any work.
 - b. Plumbing Contractor shall provide H-20 rated concrete relieving pad and heavy duty rated access covers as noted on plumbing drawings and details.
 - c. Provide access covers extended to grade. Verify required height of access cover extensions in field prior to order of grease interceptor unit. Final height of access covers shall allow grade to slope away from access covers and prevent ponding of water at access covers. Coordinate grades and slopes with site contractor to prevent ponding of water prior to beginning any work.
 - d. Provide manufacturers recommended anti-flotation device where water table could exceed lowest level of grease interceptor installation.

END OF SECTION 223000

SECTION 223400 - FUEL-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Gas fired domestic water heaters.
 - 2. Water heater accessories.
- B. Related Section: Following Division 22 Sections contain requirements that relate to this Section:
 - 1. Section 22 0519, "Meters and Gages for Plumbing Piping"
 - 2. Section 22 0548, "Vibration and Isolation for Plumbing Piping and Equipment"
 - 3. Section 22 0553, "Identification for Plumbing Piping and Equipment"
 - 4. Section 22 0719, "Plumbing Piping Insulation"
 - 5. Section 22 1005, "Plumbing Piping"
 - 6. Section 22 1006, "Plumbing Piping Specialties"

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, finishes and coatings, required clearances, methods of assembly of components, and piping and wiring connections.
- C. Product Options: Drawings indicate size, profiles, connections, dimensional requirements, and characteristics of water heaters and accessories and are based on specific types and models indicated.
- D. Setting Drawings with templates and directions for installing foundation bolts, anchor bolts, and other anchorages.
- E. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between factory-installed and field-installed wiring.
- F. Product certificates signed by manufacturers of water heaters certifying that their products comply with specified requirements.

- G. Certificates of shop inspection and data report as required by provisions of ASME Boiler and Pressure Vessel Code, when ASME construction is indicated.
- H. Maintenance data for water heaters to include in operation and maintenance manuals specified in Division 01. Include startup instructions.

1.4 CERTIFICATIONS

- A. AGA Standards: Comply with AGA standards and bear AGA (CSA International) certification label.
- B. ASME Boiler and Pressure vessel code, section IV, Part HLW
- C. ANSI Z21.10.3 /CSA 4.3 “Gas Water Heaters”
- D. ASHRAE/IES 90.1
- E. DOE/EPA Energy Star
- F. ISO 9001 Quality Management System
- G. CSD-1 “Controls and Safety Devices for Automatically Fired Boilers”
- H. NFPA 70- National Electric Code
- I. NFPA 54- National Fuel Gas Code
- J. NSF/ANSI Standard 61- Drinking Water System Components
- K. NSF/ANSI Standard 372 – Drinking Water System Components – Lead Content
- L. NSF 5 – Water Heaters, Hot Water Supply Boilers and Heat Recovery Equipment
- M. ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

1.5 QUALITY ASSURANCE

- A. Listing: The water heater will be listed ETL listed to UL 795 or ANSI Z21.10.3/CSA 4.3 “Gas Water Heaters”
- B. ASME Compliance: Water heater shall bear the ASME HLW stamp and be National Board listed
- C. Water heaters with full rated input between 199,000 and 300,000 BTU will operate at a minimum 95.3% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).

- D. The water heater will comply with current ASHRAE 90.1 requirements.
- E. Water heater manufacturer certified to the ISO 9001 International Quality System.

1.6 WARRANTY

- A. Manufacturer's Warranty: The Pressure vessel/tank shall carry an unconditional 5 year warranty against leakage due to defects in materials or workmanship or corrosion. The heat exchanger tubes/combustion chamber assembly shall be warranted against failure due to thermal stress failure or condensate corrosion for a prorated five year period. Component parts shall carry a limited 1 year warranty against defects in materials or workmanship. A Warranty Certificate must be issued to the Owner from the manufacturer and a copy of warranty be submitted for Engineer's approval.
- B. Warranty period shall begin at date of final inspection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Commercial, High-Efficiency, Down-Fired Powered-Burner Design, Low-NOx, Power Vent, Gas Water Heaters:
 - 1. Bradford-White Corp.
 - 2. Laars
 - 3. Rheem Triton
 - 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.
- B. The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses as established for gas fired water heaters.

2.2 CONSTRUCTION

- A. Specified manufacturer's standard components and features are acceptable where specific product requirements are not indicated.
- B. Temperature Control: Adjustable thermostat, except for units where other arrangement is indicated or temperature is regulated by flow-control fitting.
- C. Safety Control: Automatic, high-temperature-limit cutoff device or system on commercial units and where indicated. Include automatic low-water cutoff device or system on commercial units where indicated.
- D. Interior Finish: Materials that comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.

- E. Tappings: Factory fabricated of materials compatible with tank. Include tappings for piping connections, relief valves, pressure gage, thermometer, blow down, CPVC vent, and controls as required and others as indicated. Attach tappings to tank before testing and labeling. Include tappings and connections as follows:
 - 1. 2-Inch NPS (DN50) and Smaller: Threaded ends.
 - 2. 2-1/2-Inch NPS (DN65) and Larger: Flanged ends.
- F. Insulation: Fiberglass, polyurethane foam, or manufacturer's standard that is suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls.
- G. Jacket: Steel, with baked-on enamel finish, except where otherwise specified.
- H. Anode Rods: Factory installed, magnesium.

2.3 COMMERCIAL, HIGH-EFFICIENCY, DOWN-FIRED POWERED-BURNER DESIGN, LOW-NOX, POWER VENT, GAS FIRED WATER HEATERS:

- A. Description: ASHRAE/IES 90.1-1999, commercial, storage, powered-vent, high efficiency gas water heater; with capacity more than 40 gal. and natural-gas input more than 75,000 Btuh.
- B. Storage Tank Construction: ASME labeled, steel with 150-psig working-pressure rating.
- C. Meets or exceeds SCAQMD R1146.2 low NOx requirements.
- D. Burner: Manufacturer's standard, for use with powered-vent water heaters and natural-gas fuel.
- E. Gas Shutoff Valve: ANSI Z21.15, manually operated. Furnish for installation in piping.
- F. Pressure Regulator: ANSI Z21.18, factory or field installed, for gas appliances. Provide regulators with pressure rating, capacity, and pressure differential required for water heater and gas supply.
- G. Automatic Ignition: ANSI Z21.20, automatic gas-ignition system and components.
- H. Automatic Valve: ANSI Z21.21, appliance, automatic gas valve.
- I. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 and ANSI Z21.22. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.
- J. Inlet and Outlet Manifolds: Fabricated by water heater manufacturer and capable of providing balanced flow through water heaters, for multiple-unit installation.

- K. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 and ANSI Z21.22. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.
- L. Advanced Electronic Controls: Microprocessor controls ignition and thermostat, with adjustment of water temperature from 100 deg. F to 180 deg. F.
- M. Basis of Design: Bradford White EF Series Ultra High Efficiency Water Heaters
 - 1. DWH-1 (Building Hot Water Supply): EF-100T-199E-5NA (Qty.2)
 - a. Storage capacity: 100 gal. (ea.)
 - b. Gas input: 199,999 BTU (ea.)
 - c. Recovery: 235 gal./hr@100F (ea.)
 - d. First Hour Delivery: 309 gal. (ea.)
 - e. Vent Piping: Sch. 40 PVC
 - f. Air Intake Piping: Sch. 40 PVC
 - g. Accessories:
 - 1) Expansion Tank - Amtrol Model ST-12-C, 4.7 gallons., ASME Construction

2.4 OPTIONS: TO BE PROVIDED

- A. Condensate neutralization system
- B. Vent Termination Kit
- C. Installation Kit
- D. Factory Authorized Startup

PART 3 - EXECUTION

3.1 CONCRETE BASES

- A. Install concrete bases minimum of 4 in thick, and of adequate dimensions for indicated water heaters and accessories. Refer to Division 03 Section "Cast-in-Place Concrete" and Division 22 Sections. Coordinate requirement for pad with G.C.

3.2 WATER HEATER INSTALLATION

- A. The storage and heating sections shall be completely factory packaged on a single skid, requiring only job site hookup to utilities, venting, and plumbing. The heater shall be insulated to meet current ASHRAE 90.1 standby loss requirements and jacketed with a polyethylene liner consisting of 100% recycled material. Pressure vessel shall include a ball-type drain valve. The heater shall fit properly in the space provided and installation shall conform to all local, state, and national codes.

- B. General: Install water heaters on concrete bases. Set and connect units according to manufacturer's written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturer's recommended clearances. Install so controls and devices are accessible for service.
- C. Anchor water heaters and storage tanks to substrate.
- D. Install seismic restraints as required by IBC and as specified.
- E. Install and connect gas water heaters in accordance with IFGC 2018 and NFPA 54.
 - 1. Install appropriately sized gas pressure regulator on gas-burner inlets. Coordinate gas inlet pressure with plumbing drawings and water heater gas supply pressure with manufacturer prior to order/installation.
 - 2. Install vent piping from gas burner pressure regulators and valves to building exterior in accordance with IFGC. Terminate vent piping with brass-screened vent cap fitting. Do not combine vents except with approval of authorities having jurisdiction.
- F. Install temperature and pressure relief valves in top portion of storage water heater tanks and hot-water storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.
- G. Install pressure relief valves in hot-water-outlet piping for water heaters without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.
- H. Install vacuum relief valves in cold-water-inlet piping.
- I. Install vacuum relief valves in water heaters and hot-water storage tanks that have copper lining.
- J. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Section 221006 "Plumbing Piping Specialties" for drain valves.
- K. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Section 220519 "Meters and Gages for Plumbing Piping"
- L. Install pressure gages on water heater inlet and outlet piping. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping"
- M. Install piping adjacent to water heaters to allow service and maintenance.
- N. Arrange for field-applied insulation on equipment and piping not furnished with factory-applied insulation.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Connect hot- and cold-water piping to units with shutoff valves and unions. Where indicated, connect hot-water circulating piping to unit with shutoff valve, check valve, and union.
 - 2. Connect gas piping to gas burner with drip leg, tee, shutoff valve, and union; minimum size same as inlet connection. Gas piping is specified in Section 221006 "Plumbing Piping."
 - 3. Make connections with dielectric fittings where piping is made of dissimilar metals. Dielectric fittings are specified in Section 221006 "Plumbing Piping Specialties."
- B. Electrical Connections: Power wiring and disconnect switches are specified in Division 26 Sections. Arrange wiring to allow unit servicing.
- C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

- A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.
 - 1. Test/adjust operating/safety controls. Replace damaged/malfunctioning controls/equipment.
 - 2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 3. Review data in the operation and maintenance manuals. Refer to Division 01 Section "Contract Closeout".
 - 4. Review data in the operation and maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
 - 5. Schedule training with the Owner with at least 7 days advance notice.
- B. Perform the following final checks before startup:
 - 1. Fill water heaters with water.
 - 2. Charge expansion tanks with air.
 - 3. Check that piping system tests are complete.
 - 4. Check for piping connection leaks.
 - 5. Check for adequate combustion air.
 - 6. Check for clear vents and devices.
 - 7. Check for clear relief valve inlets, outlets, and drain piping.
 - 8. Check operation of pumps and circulators.
 - 9. Test operation of safety controls, relief valves, and devices.

C. Perform the following startup procedures:

1. Adjust operating controls.
 - a. Adjust hot-water-outlet temperature settings.

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electric Water Coolers
- B. Emergency Eyewash
- C. Lavatories
- D. Laundry Tub
- E. Mop Receptors
- F. Sinks.
- G. Urinals
- G. Water Closets

1.2 RELATED REQUIREMENTS

- A. Division 07 - Joint Sealers: Seal fixtures to walls and floors.
- B. Section 22 1005 - Plumbing Piping.
- C. Section 22 1006 - Plumbing Piping Specialties.
- D. Section 22 3000 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

- A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2004.
- B. ARI 1010 - Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; Air-Conditioning and Refrigeration Institute; 2002.
- C. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).
- D. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.
- E. ASME A112.19.2 - Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals; The American Society of Mechanical Engineers; 2003.

- F. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 2005.
- G. ICC/ANSI A117.1-2003 - Accessible and Usable Buildings and Facilities; 2003
- H. IBC2018 - ICC - International Building Code; 2018
- I. IPC2018 - ICC - International Plumbing Code; 2018
- J. IFGC2018 - ICC - International Fuel Gas Code; 2018

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data for all Plumbing Fixtures specified herein and on the Plumbing Drawings. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
- C. Maintenance Data: Submit maintenance data including installation instructions, routine maintenance instructions, spare parts lists, and exploded assembly views for each plumbing fixture. Include this data in Maintenance Manual.
- D. Review of submittals which do not clearly indicate the information noted above may be delayed or Rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer. Warranty period shall begin after final payment.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- B. Plumbing Fixtures shall be manufactured and installed in accordance with standards set forth in IPC. Where "Accessible" fixtures are required, the fixture shall be manufactured and installed in accordance with ICC/ANSI A117.1.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY

- A. Provide five year manufacturer warranty for electric water coolers.

1.9 EXTRA MATERIALS - Furnish the following for owner's use in maintenance of project.

- A. Furnish the following items for Owner's use in maintenance of project.
 - 1. Extra Faucet Cartridges: Two sets for each type faucet installed.
 - 2. Extra Lavatory Supply Fittings: Two sets for each type lavatory installed.
 - 3. Extra Sink Supply Fittings: Two sets for each type sink installed.
 - 4. Extra Toilet Seats: Two of each type installed.
 - 5. Flush Valve Service Kits: Two for each type installed.
- B. See Division 01 - Project Requirements, for additional provisions.

PART 2 - PRODUCTS

2.1 FIXTURES AND MANUFACTURED PRODUCTS:

- A. General: Provide factory-fabricated fixtures and equipment recommended by the manufacturer for use in the service indicated.
- B. Fixture Manufacturers:
 - 1. All items specified herein shall be manufactured by the manufacturer listed or other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.

2.2 ELECTRIC WATER COOLERS - REFER TO DRAWINGS FOR LOCATIONS.

- A. Electric Water Cooler Manufacturers:
 - 1. Halsey Taylor.
 - 2. Elkay.
 - 3. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
- B. (EWC-1) SURFACE MOUNTED, BI-LEVEL BARRIER FREE ELECTRIC WATER COOLER W/ BOTTLE FILLING STATION:

1. Water Cooler: Electric, mechanically refrigerated; surface mounted with; stainless steel basin with Real Drain, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, vandal resistant front push button, wall mounting bracket; integral air cooled condenser, with water filter.
2. Bottle Filling Station: Sensor Activated, visual filter monitor, green counter, laminar flow antimicrobial
3. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
4. Electrical: 115V, 60Hz, 4.0Amps chiller, manufacturer provided cord and plug electrical connection
5. Accessories: Sch.40 PVC p-trap, wheel handle quarter turn stop with flexible hose supply. Provide dielectric fittings where required by manufacturer's installation instructions. Provide cane touch skirt where required for compliance with ADA/ANSI A117.1 requirements for protruding objects.
6. ADA/ANSI A117.1 compliant for juvenile
7. Basis of Design:
 - a. Halsey Taylor; Model HTHB-HVRGRN8BL-WF

2.3 EMERGENCY EYEWASH

A. Manufacturers:

1. Haws Co.: www.hawscow.com
2. Guardian Equipment: gesafety.com
3. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Emergency Eyewash (EW-1) - Boiler Room

1. Wall mounted unit with mounting bracket and signage, and emergency equipment thermostatic mixing valve unit, refer to Section 22 1006 "Plumbing Piping Specialties" for additional information.
 - a. Basis of Design:
 - 1) Guardian Model 1750P Plastic Wall Mount Eye/Face Wash
2. Water Supply:
 - a. 1/2" Tempered supply from Tempering Valve (ETV-1)
3. Provide thermostatic mixing valve, mounted on wall above unit to supply tepid water to emergency eyewash.

2.4 LAVATORIES

A. Manufacturers:

1. Basin:
 - a. American Standard Inc: www.americanstandard.com.
 - b. Kohler Company: www.kohler.com.
 - c. Zurn Industries, Inc: www.zurn.com.
 - d. TOTO USA, Inc: www.totousa.com
 - e. Other acceptable manufacturers offering equivalent products as approved

- by Architect/Owner. Refer to Division 01 specifications for additional information.
2. Electronic Sensor Operated Faucets:
 - a. Sloan Valve Company: www.sloanvalve.com.
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
 3. Manual Faucets:
 - a. Powers Controls: www.powerscontrols.com
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
 4. Carriers:
 - a. JOSAM Company: www.josam.com.
 - b. J.R. Smith Company: www.jrsmith.com.
 - c. Mifab Drainage Products
 - d. Zurn Industries, Inc: www.zurn.com.
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
- B. (LAV-1) LAVATORY, WALL HUNG-ELECTRONIC SENSOR FAUCET - (Gang Toilet Rooms & Nurse) Refer to Drawings for locations.
1. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20 by 18 inch minimum, with 4-inch-high back, rectangular basin with splash lip, front overflow, and soap depression. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
 - a. Drilling Centers: 4 inch.
 - b. Basis of Design: American Standard Inc; Lucerne 0355.012, 20" x 18", wall hung, drilled for concealed arm carrier system
 2. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
 - a. Spout Style: Standard.
 - b. Power Supply: 24 VAC.
 - 1) Direct wired to junction box.
 - 2) For 24V applications, provide above ceiling mounted transformer and all low voltage wiring from transformer to faucets/flush valves. Power wiring to transformer shall be provided by the E.C.
 - c. Water Supply: 3/8-inch compression connections.
 - d. Aerator: Vandal resistant, 0.5 GPM.
 - e. Finish: Polished chrome.
 - f. Basis of Design:
 - 1) Sloan Valve Company: Model Optima Series ETF-600-BDT-EL154
 3. Accessories:
 - a. Mixing Valve: Below deck thermostatic tempering valve that meets ASSE 1070 standard.
 - b. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 - c. Offset waste with perforated open strainer.
 - d. Screwdriver/loose key quarter-turn chrome plated angle stops.
 - e. Flexible copper or braided stainless-steel supplies as applicable.
 - f. Truebro Lav Shield - Custom factory precut, PVC, China white,

w/stainless steel wall anchors, ANSI A117.1 compliant and installed in accordance with ANSI A117.1 requirements. Locate all equipment/accessories associated with the electronic faucet and the mixing valve within this shield.

4. Carrier:
 - a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.
- C. (LAV-2) LAVATORY, WALL HUNG - MANUAL FAUCET - (Faculty Toilets) Refer to Drawings for locations.
1. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20 by 18 inch minimum, with 4-inch-high back, rectangular basin with splash lip, front overflow, and soap depression. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
 - a. Drilling Centers: 4 inch.
 - b. Basis of Design: American Standard Inc; Lucerne 0355.012, 20" x 18", wall hung, drilled for concealed arm carrier system.
 2. Manual Operated Faucet: Solid Cast brass, chrome plated, deck mounted.
 - a. Spout Style: Standard.
 - b. Controls: Single Lever ADA compliant chrome plated metal handle
 - c. Water Supply: 3/8-inch compression connections.
 - d. Aerator: Vandal resistant, 0.5 GPM.
 - e. Mixing Valve: Integral thermostatic mixer meeting ASSE 1070 to 0.5gpm minimum flow
 - f. Finish: Polished chrome.
 - g. Basis of Design:
 - 1) Powers TempTap P1070A5
 - 2) Watts Lavsafe: P1070
 3. Accessories:
 - a. Chrome plated 17-gauge brass P-trap with clean-out plug and arm with escutcheon.
 - b. Offset waste with perforated open strainer.
 - c. Screwdriver/loose key quarter-turn chrome plated angle stops.
 - d. Flexible copper or braided stainless-steel supplies as applicable.
 - e. Truebro Lav Shield - Custom factory precut, PVC, China white, w/stainless steel wall anchors, ANSI A117.1 compliant and installed in accordance with ANSI A117.1 requirements. Locate all equipment/accessories associated with the mixing valve within this shield.
 4. Carrier:
 - a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

2.5 LAUNDRY TUB (LT-1) - REFER TO DRAWINGS FOR LOCATIONS.

A. Manufacturers:

1. Sink:
 - a. Fiat Products: www.fiatproducts.com
 - b. Mustee: www.mustee.com

- c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
- 2. Supply Faucet:
 - a. Chicago Faucet, Inc Commercial Faucets:
 - b. Delta Faucet, Commercial Faucets: www.deltafaucets.com
 - c. Moen Commercial: www.moen.com
 - d. T&S Brass: www.tsbrass.com
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

B. (LT-1) - Single Compartment Laundry Tub – (Refer to Floor Plans)

- 1. Sink: ASME A112.19.3; 23 1/8 in. (front to back) by 20 in. (side to side) by 14 3/8 in. deep, nominal outside dimensions. White baked enamel steel angle legs. (2-hole punch).
 - a. Drain: 3-1/2 inch rotary lever, with grid strainer and 1-1/2" 17 ga. tailpiece.
 - b. Basis of Design:
 - 1) Fiat Products: SF-1-F
- 2. Faucet: ASME A112.18.1; chrome plated solid brass supply with high rise 5 1/4" swivel gooseneck spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, 4-inch vandal proof wrist blade indexed lever handles.
 - a. Basis of Design:
 - 1) Chicago Faucet: 895-317-GN2AE35ABCP
- 3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated 1/4 turn angle stops, rigid chrome plated copper or flexible woven stainless-steel supplies.

2.6 MOP RECEPTOR (MR-1)

A. Refer to detail on plans for additional accessories and requirements.

B. Manufacturers:

- 1. Basin:
 - a. Florestone: www.florestone.com
 - b. Fiat www.fiat.com
- 2. Faucet
 - a. Delta Commercial Faucets: www.deltafaucet.com
 - b. Chicago Commercial Faucet, Inc: www.chicagofaucets.com

C. (MR-1) 36in x 36in Mop Receptor

- 1. Basin: 36 in. x 36 in. terrazzo drop front mop sink, 3" integral drain, with flanges
 - a. Basis of Design: Florestone Model 91
- 2. Faucet: Chrome plated cast Brass, integral vacuum breaker, pail hook, wall support
 - a. Basis of design: Delta Commercial, Model 28C2383
 - b. Install check valves on hot and cold water supplies to faucet.

3. Accessories
 - a. Wall Guards: Florestone Model MR-377 (2) 36" Stainless Steel.
 - b. Mop Hanger: Florestone Model MR-372 with 3 grips on stainless steel wall bracket.
 - c. Hose Hanger: Florestone Model MR-370 with 36" hose and wall hanger.
4. Provide cold water hose bibb adjacent to janitor's sink assembly. Hose Bibb shall be Woodford model 101C with 1/2" sweat fitting inlet, 3/4" male hose thread outlet connection, integral vacuum breaker, and patented check, adjustable polycarbonate wall flange. Install with drop front toward service side.

2.7 SINKS - Refer to drawings for locations.

A. Manufacturers:

1. Sink:
 - a. Just Manufacturing Co.: www.justmfg.com.
 - b. Elkay Corporation: www.elkayusa.com.
 - c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
2. Supply Faucet:
 - a. Chicago Faucet, Inc Commercial Faucets:
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. (SINK-1) - Single Compartment Bowl – (General Classrooms):

1. Sink: ASME A112.19.3; 20" by 22" by 5-1/2" outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch) and right/left side bubbler. Verify "Standard and ADA-Accessible" sink requirements and locations with Architectural Interior Elevation Plans prior to rough in.
 - a. Drain: Type 304 stainless steel grid strainer and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl)
 - b. Basis of Design:
 - 1) ADA- Just Manufacturing; Model CRBADA2022A55-J (5-1/2" Deep, Center-Rear Drain)
2. Faucet: ASME A112.18.1; chrome plated brass supply with 8" rigid/swing gooseneck spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
 - a. Basis of Design: Chicago #1100-GN8AE35VP-317ABCP
3. Bubbler: Sink mounted bubbler unit, Elkay Model LKBH1141A with cold water provided from sink supply, with in-line shut-off valve.
4. Accessories: Chrome plated 17-gauge P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies (Verify with Owner).
5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).

C. (SINK-2) Single Compartment Bowl w/Deck Mounted Eyewash – (Exam Room)

1. Sink: ASME A112.19.3; 19" by 21" by 5-1/2" outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch).
 - a. Drain: 3-1/2-inch stainless steel basket strainer and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl)
 - b. Basis of Design:
 - 1) Just Manufacturing; Model SLADA1921A55-J (5-1/2" Deep, Rear Center Drain).
2. Faucet: ASME A112.18.1; chrome plated cast brass body with 8" rigid/swing gooseneck spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
 - a. Basis of Design:
 - 1) Chicago #1100-GN8AE35VP-317ABCP
3. Accessories: Chrome plated 17 gage cast brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies (Verify with Owner).
4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).
5. Provide w/Sink mounted drench hose eyewash unit: Haws model 8904 deck mounted (countertop) with dual 45-degree angled heads with caps and SP212 vacuum breaker. Provide below deck, mounted thermostatic mixing valve to supply tepid water to eyewash unit; Powers model ES-150-11 with hot/cold water provided off sink supplies, with in-line shut-off valves.

D. (SINK-3) - Single Compartment Bowl - (Nurse Office)

1. Sink: ASME A112.19.3; 15" by 17-1/2" by 5-1/2" outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch).
 - a. Drain: 3-1/2-inch stainless steel basket strainer and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl)
 - b. Basis of Design:
 - 1) Just Manufacturing; Model SLADA1815A55-J (5-1/2" Deep, Center Drain)
2. Faucet: ASME A112.18.1; chrome plated brass with 5-1/4" rigid/swing gooseneck spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
 - a. Basis of Design:
 - 1) Chicago #1100-GN2AE35VP-317AB
3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies (Verify with Owner).
4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).

E. (SINK-4) - Single Compartment Bowl - (Faculty Work Room, Library)

1. Sink: ASME A112.19.3; 19" by 21" by 5-1/2" inch outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch).

- a. Drain: 3-1/2-inch stainless steel basket strainer and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl)
 - b. Basis of Design:
 - 1) Just Manufacturing; Model SLADA1921A55-J (5-1/2" Deep, Center-Rear Drain)
 2. Faucet: ASME A112.18.1; chrome plated brass with 8" rigid/swing gooseneck spout, water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
 - a. Basis of Design:
 - 1) Chicago #1100-GN8AE35-317ABCP
 3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies (Verify with Owner).
 4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).
- F. (SINK-5) - Double Compartment Bowl – (Faculty Dining)
1. Sink: ASME A112.19.3; 19-1/2" by 33" by 5-1/2" outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (4-hole punch).
 - a. Drain: 3-1/2-inch stainless steel basket strainer and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl)
 - b. Basis of Design:
 - 1) Just Manufacturing; Model DLADA1933A55-J (5-1/2" Deep, Center-Rear Drain)
 2. Faucet: ASME A112.18.1; chrome plated brass with 10 in. swivel spout, water economy aerator with maximum 1.5 gpm flow, 4" lever handle, ceramic cartridge, with side spray, ADA compliant.
 - a. Basis of Design:
 - 1) Chicago #2301-8E34ABCP
 4. Accessories: Chrome plated continuous waste, chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies (Verify with Owner).
 5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).
- G. (SINK-6) - Single Compartment Bowl – (Art Room – ADA):
1. Sink: ASME A112.19.3; 21" by 25" by 5-1/2" inch outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch). Verify "Standard and ADA-Accessible" sink requirements and locations with Architectural Interior Elevation Plans prior to rough in.
 - a. Drain: 3-1/2-inch Type 304 stainless steel basket strainer and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl).
 - b. Basis of Design:
 - 1) ADA- Just Manufacturing; Model SLADA2125A55-J (5-1/2" Deep, Center-Rear Drain)
 2. Faucet: ASME A112.18.1; chrome plated brass with 8" rigid swing gooseneck spout, vandal proof water economy aerator with maximum 1.5

gpm flow, 1/4 turn ceramic cartridge, ADA compliant.

a. Basis of Design:

1) Chicago #1100-GN8AE35VR-317ABCP

3. Accessories: Chrome plated 17 gage brass tailpiece with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies as applicable.
4. P-trap not required. Provide w/plaster trap. Refer to Plumbing Detail Drawings and specification section 221006 for additional installation requirements.
5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).

H. (SINK-7) - Double Compartment Free Standing Sink w/Sideboards Unit – (Art Rooms):

1. Sink: Stainless steel commercial work sink; 74" by 23 13/16" by 12" bowl depth, 16 gauge, 300 series stainless steel, with ledge back drilled for trim (2-hole punching), (2) 18" drain boards, 1 5/8" diameter galvanized steel legs.
 - a. Drain: (2) 3-1/2-inch Type 304 stainless steel basket strainer and tailpiece.
 - b. Basis of Design:
 - 1) Elkay #2C18x18-2-18X-CT-1 (30" Special Working Height)
2. Faucet: Chrome plated brass with 8" centers and 12" L-type swing spout, 2.2 gpm, Quaturn compression cartridge w/lever handles, low lead.
 - a. Basis of Design:
 - 1) Chicago #540-LDL12ABCP
3. Accessories: Chrome plated 17 gauge brass tailpiece with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies (Verify with Owner).
4. P-trap not required. Provide w/plaster trap. Refer to Plumbing Detail Drawings and specification section 221006 for additional installation requirements.

I. (SINK-8) Hand Sink – (Kitchen)

1. Sink: ASME A112.19.3; 16-3/4" by 15-1/2" by 6 inch outside dimensions, 20 gauge thick, Type 304 stainless steel, with side splashes and ledge back drilled for faucet (2-hole punch).
 - a. Drain: LK-8 drain fitting and tailpiece included with sink.
 - b. Basis of Design:
 - 1) Elkay; Model CHS1716LRSC
2. Faucet: ASME A112.18.1; Gooseneck faucet included with sink
3. Accessories: Below deck thermostatic tempering valve that meets ASSE 1070 standard, Chrome plated P-trap (furnished with sink) with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies (Verify with Owner).

J. (SINK-9) Food Prep Table with Sink – (Kitchen)

1. Sink: NSF approved; overall dimensions 72 in. x 30 in. x 35-3/4 in high, single compartment 16 in. x 20 in. x 10 in. deep sink bowl on left, radius corners, 18 gauge thick, 304 series stainless steel, 6 in. back splash, Custom 8" o.c. deck mount faucet holes, basket drain, adjustable stainless steel undershelf and stainless steel legs with stainless steel adjustable bullet feet.
 - a. Drains: (1) drain w/basket strainer and tailpiece included with sink.
 - b. Basis of Design:
 - 1) BK Resources; Model BKPT-3072S-L
 - 2) Elkay: Model LK50-8980
2. Faucet: ASME A112.18.1; NSF/ANSI 61 & 372, chrome plated, L type swing spout, 1.5 gpm aerator, lever handles, 8" centers.
 - a. Basis of Design:
 - 1) Chicago, Model 1100-L9E35ABCP

K. (SINK-10) Triple Compartment Scullery Sink – (Kitchen)

1. Sink: NSF approved; overall dimensions 114 in. x 31 in. x 37.5 in high, 3-compartments 24 in. x 24 in. x 14 in. deep, 5/8" coved radius tub corners, Left & Right drain boards 24 in. wide, 14 gauge, 300 series stainless steel, 9-1/2 in. back splash drilled for trim (2-hole punch – 2 required), raised rolled edges, legs are stainless steel tubing with stainless steel adjustable feet. Provide optional lever drain.
 - a. Drains: (3) 3-1/2- inch drains w/basket strainer and tailpiece and optional lever drain.
 - b. Basis of Design:
 - 1) Eagle Group; Model FN2472-3-18-14/3
2. Faucet: Pre-rinse faucet, chrome plated, ASME A112.18.1; NSF/ANSI 61 & 372, 8" body with quatern compression cartridges and lever handles, 3/8" offset inlet supply arms with integral check valves, 1.0 gpm spray valve, riser with spring guide, 44in. flexible Stainless Steel hose with insulated handle, pipe strap and hook assembly. Secondary faucet: chrome plated, L type swing spout including quatern cartridge with lever handle and full flow outlet.
 - a. Basis of Design:
 - 1) Chicago #510-G613L15XKCAB (2 required).

L. (SINK-11) Sink – (Cafeteria)

1. Sink: ASME A112.19.3; 22" by 19" by 5-1/2 inch outside dimensions, 18 gauge thick, Type 304 stainless steel, with 2-1/2" high backsplash, 2-1/2" apron front and rear ledge drilled for 3 faucet holes on 2" centers, ADA Compliant.
 - a. Drain: Elkay LK-174 perforated grid drain fitting and tailpiece.
 - b. Basis of Design:
 - 1) Elkay; Model ELV2219CS3
2. Faucet: ASME A112.18.1; 5-1/4" Rigid/Swing Gooseneck spout, chrome plated, 1.5 GPM Aerator
 - a. Basis of Design:
 - 1) Chicago, Model 317GN2AE35VPABCP

3. Accessories: Below deck thermostatic tempering valve that meets ASSE 1070 standard, Chrome plated P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or woven stainless-steel supplies (Verify with Owner).
4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84.

2.8 URINALS

A. Manufacturers:

1. Urinal
 - a. American Standard Inc: www.americanstandard.com.
 - b. Kohler Company: www.kohler.com.
 - c. Zurn Industries, Inc: www.zurn.com.
 - d. TOTO USA, Inc: www.totousa.com
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
2. Flush Valves:
 - a. Sloan Valve Company: www.sloanvalve.com.
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
3. Carriers:
 - a. JOSAM Company: www.josam.com.
 - b. J.R. Smith Company: www.jrsmith.com.
 - c. Mifab Drainage Products
 - d. Zurn Industries, Inc: www.zurn.com.
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. (UR-1) URINAL - WALL HUNG-SENSOR OPERATED FLUSH VALVE (Student Gang Toilet Rooms) Refer to drawings for locations.

1. Urinal: Vitreous china, ASME A112.19.2, washout style, wall hung with side shields and concealed carrier. Mount at standard and ADA height units as designated on Architectural Interior Elevation Plans.
 - a. Flush Volume: 0.5 gallon, maximum.
 - b. Flush Style: Washout.
 - c. Flush Valve: Exposed (top spud).
 - d. Flush Operation: Sensor Operated
 - e. Trap: Integral.
 - f. Removable stainless steel strainer.
 - g. Supply Size: 3/4 inch.
 - h. Outlet Size: 2 inches.
 - i. Basis of Design:
 - 1) American Standard Inc; Model Washbrook 6501.010, wall hung, top spud
2. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
 - a. Sensor-Operated Type: Solenoid operator, low voltage hard-wired, infrared sensor and True Mechanical Over-ride push button on valve body.
 - b. Power Supply: 24 VAC.

- 1) Direct wired to junction box.
- 2) For 24V applications, provide above ceiling mounted transformer and all low voltage wiring from transformer to faucets/flush valves. Power wiring to transformer shall be provided by the E.C.
- c. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
- d. Basis of Design:
 - 1) Sloan Valve Company; Model Optima Series 186-0.5-ES-S TMO, EL-154 transformer and all necessary low voltage cables for complete installation: www.sloanvalve.com.
3. Carriers:
 - a. ASME A112.6.1M; compact adjustable cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.9 WATER CLOSETS

A. Manufacturers (All Water Closets)

1. Bowl:
 - a. American Standard Inc: www.americanstandard.com.
 - b. Kohler Company: www.kohler.com.
 - c. TOTO USA, Inc.: www.totousa.com
 - d. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
2. Flush Valves:
 - a. Sloan Valve Company: www.sloanvalve.com.
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
3. Seats:
 - a. Bemis Manufacturing Company: www.bemismfg.com.
 - b. Church Seat Company: www.churchseats.com.
 - c. Olsonite: www.olsonite.com.
 - d. Zurn industries, Inc: www.zurn.com.
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.
4. Carriers:
 - a. JOSAM Company: www.josam.com.
 - b. J.R. Smith Company: www.jrsmith.com.
 - c. Mifab Drainage Products
 - d. Zurn Industries, Inc: www.zurn.com.
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

- B. (WC-1) - WATER CLOSET, SENSOR OPERATED FLUSH VALVE, WALL HUNG - (Student Gang Toilet Rooms) Refer to Drawings for locations.

1. Bowl: Vitreous china with EverClean, ASME A112.19.2, elongated rim, wall hung, siphon jet flush action, bolt caps. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
 - a. Flush Volume: 1.6 gallon, maximum.
 - b. Flush Valve: Exposed (top spud).
 - c. Flush Operation: Sensor operated.
 - d. Supply Size: 1-1/4 inches.
 - e. Outlet Size: 4 in.
 - f. Basis of Design:
 - 1) American Standard Inc; Model AFWall 3351.101 wall hung, elongated, top spud with Permanent EverClean antimicrobial surface.
 2. Flush Valve: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
 - a. At all accessible locations coordinate rough in dimensions with grab bar locations prior to rough in.
 - b. Sensor-Operated Type: Solenoid operator, low voltage hard-wired, infrared sensor and True Mechanical Over-ride push button on valve body.
 - c. Exposed Type: All Chrome plated, sweat solder adapter with cover tube and cast wall flange, 1" screwdriver angle stop w/vandal resistant stop cap.
 - d. Power Supply: 24 VAC.
 - 1) Direct wired to junction box.
 - 2) For 24V applications, provide above ceiling mounted transformer and all low voltage wiring from transformer to faucets/flush valves. Power wiring to transformer shall be provided by the E.C.
 - e. Basis of design:
 - 1) Sloan Valve Company; Model 111-1.6-ES-S TMO, EL-154 transformer and all necessary low voltage cables for complete installation
 - 2) Substitutions: See Division 01 - Product Requirements.
 3. Seats:
 - a. Solid white plastic, antimicrobial, open front, extended back, stainless steel self-sustaining hinge, brass bolts, without cover.
 4. Water Closet Carriers:
 - a. ASME A112.6.1M; adjustable compact cast iron frame, integral drain hub and vent, metal nipple assembly, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. Provide horizontal and vertical drain units as required by installation methods.
- C. (WC-2) - WATER CLOSET, MANUAL OPERATED FLUSH VALVE, WALL HUNG - (Faculty and Nurse Toilets) Refer to Drawings for locations.
1. Bowl: Vitreous china with EverClean, ASME A112.19.2, elongated rim, wall hung, siphon jet flush action, china bolt caps. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
 - a. Flush Volume: 1.6 gallon, maximum.
 - b. Flush Valve: Exposed (top spud).
 - c. Flush Operation: Manual operated.
 - d. Supply Size: 1-1/4 inches.
 - e. Outlet Size: 4 in.
 - f. Basis of Design:
 - 1) American Standard Inc; Model AFWall 3351.101 wall hung, elongated, top spud with Permanent EverClean antimicrobial surface.

2. Flush Valve: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
 - a. At all accessible locations coordinate rough in dimensions with grab bar locations prior to rough in.
 - b. Manual-Operated Type: Oscillating non-hold open operator, chloramine resistant, Permex synthetic rubber diaphragm, filtered bypass, vacuum breaker
 - c. Exposed Type: All Chrome plated, sweat solder adapter with cover tube and cast wall flange, 1" screwdriver angle stop w/vandal resistant stop cap.
 - d. Basis of design:
 - 1) Sloan Valve Company; Model Royal 111-1.6
3. Seats:
 - a. Solid white plastic, antimicrobial, open front, extended back, stainless steel self-sustaining hinge, brass bolts, without cover.
4. Water Closet Carriers:
 - a. ASME A112.6.1M; adjustable compact cast iron frame, integral drain hub and vent, metal nipple assembly, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. Provide horizontal and vertical drain units as required by installation methods (Connect to existing carriers for Gym Toilet Rooms).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.
- C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

D. PREPARATION

1. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture "Plumbing Fixture List" for particular fixtures.
2. Verify location of "Accessible" fixtures with Architectural drawings and verify mounting requirements for all "Accessible" fixtures in accordance with ICC/ANSI 117.1. Prior to rough-in.

E. INSTALLATION

1. Install fixtures, materials and equipment in accordance with manufacturer's written instructions, roughing in drawings and details on the drawings.
2. Install all "Accessible" Fixtures in accordance with ICC/ANSI 117.1.
3. Install each fixture with trap, easily removable for servicing and cleaning.
4. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
5. Install components level and plumb.

6. Install and secure fixtures in place with concealed wall carriers and bolts or secure to floor or countertop as appropriate. Unless noted otherwise concealed carriers shall be bolted securely to the floor.
7. Seal fixtures to wall and floor surfaces with sealant as specified in Division 07, color to match fixture.

F. INTERFACE WITH WORK OF OTHER SECTIONS

1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
2. At all accessible locations coordinate rough in dimensions with grab bar locations prior to rough in.

G. ADJUSTING

1. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

H. CLEANING

1. Clean plumbing fixtures and equipment before Date of Substantial Completion.

I. PROTECTION

1. Protect installed products from damage due to subsequent construction operations.
2. Do not permit use of fixtures by construction personnel.
3. Repair or replace damaged products before Date of Substantial Completion.

J. SCHEDULES

1. Fixture Rough-In
 - a. Water Closet (Flush Valve Type):
 - 1) Cold Water: 1 1/4 inch.
 - 2) Waste: 4 Inch.
 - 3) Vent: 2 Inch.
 - b. Lavatory:
 - 1) Hot Water: 1/2 Inch.
 - 2) Cold Water: 1/2 Inch.
 - 3) Waste: 1-1/2 Inch.
 - 4) Vent: 1 1/2 inch.
 - c. Sink:
 - 1) Hot Water: 1/2 Inch.
 - 2) Cold Water: 1/2 Inch.
 - 3) Waste: 1-1/2 inch.
 - 4) Vent: 2 inch.
 - d. Janitors Sink / Service Sink:
 - 1) Hot Water: 1/2 Inch.
 - 2) Cold Water: 1/2 Inch.
 - 3) Waste: 3 inch.
 - 4) Vent: 2 inch.

- e. Electric Water Cooler:
 - 1) Cold Water: 1/2 Inch.
 - 2) Waste: 1-1/2 Inch.
 - 3) Vent: 2 Inch.
- f. Emergency Eye Wash (drench hose):
 - 1) Hot Water: 1/2 Inch to tempering valve.
 - 2) Cold Water: 1/2 Inch to tempering valve.
 - 3) Tempered Water: 1/2 Inch from tempering valve to unit

END OF SECTION 224000

SECTION 230501 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide a complete and operating HVAC system in accordance with these specifications and accompanying contract drawings. This shall include all required labor, materials, equipment, and supervision.
- B. Work shall include but is not limited to the following systems, equipment, materials, and labor for a complete system including the following:
 - 1. Ductwork
 - 2. Air Handlers
 - 3. Diffusers, grilles, and registers
 - 4. Exhaust fans and relief vents.
 - 5. Air-cooled chiller
 - 6. Hot water, chilled water, refrigerant, and condensate piping systems
 - 7. Terminal heating equipment
 - 8. Automatic temperature control system
 - 9. Boilers
 - 10. Pumps
 - 11. Rooftop units
 - 12. Energy recovery units.
- C. Where the contract drawings and specifications reference the Mechanical Contractor (M.C.), the work shall be performed by the H.V.A.C. Contractor (H.C.). The references may be used interchangeably.

1.2 DRAWINGS:

- A. Drawings are part of the bid documents and are intended to show approximate and relative locations of services and equipment. they shall not be scaled to determine exact positions, locations, and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping and duct rises, drops, offsets, valves, and related specialties are not shown. The contractor shall provide all ductwork, piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the owner.
- C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical, and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to consult other trades, this Contractor shall rearrange his work at his own expense.

1.3 FIRE UNDERWRITER SEAL:

- A. Where applicable, all material shall bear the National Board of Fire Underwriters' Seal of Approval. Certificates to this effect to be furnished to Architect upon request.

1.4 CONCRETE AND MASONRY WORK:

- A. The Contractor shall furnish and install all concrete bases, reinforcing, etc. required to install the Mechanical Work, unless otherwise noted.
- B. The Contractor, prior to installing any forms, reinforcing or concrete, shall notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete. No such work shall be placed in a manner to interfere with the proper placing of the reinforcement unless so authorized by the Architect.

1.5 ANCHOR BOLTS:

- A. Each Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished by him under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.
- B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.
- C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.6 SLEEVES:

- A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.
- B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be one pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe.

- C. Sleeves for pipes passing through non-fire rated floors: 18 gage galvanized steel.
- D. Sleeves for pipes passing through non-fire rated beams, walls, footings, and potentially wet floors: Steel pipe or 18 gage galvanized steel.
- E. Sleeves for rectangular ductwork: Galvanized steel
- F. Firestopping for non-plastic piping, ductwork shall be 3M, Dow, Corning fire caulk/packing or accepted equivalent. Refer to Division 7. Install steel angles around duct penetrations.
- G. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
- H. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material.

1.7 ESCUTCHEONS:

- A. All exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces, shall be provided with solid pattern heavy ceiling, floor or wall escutcheons with set screw. Escutcheons and plates shall be of steel or malleable iron with prime coat ready for painting. Escutcheons will not be provided where sleeves intentionally extend above finished floor.

1.8 ACCESS DOORS AND PANELS:

- A. All ceiling and wall access panels required shall be furnished by this Contractor and set by the General Contractor. The location of these access panels must be approved by the Architect prior to their installation. The Contractor shall furnish an access panel where fire dampers, valves, specialties, junction boxes, and other serviceable items are installed behind plaster, tile, or similar type non-removable surfaces.
- B. Panels shall be of suitable size and construction for each specific location. Doors shall be flush and shall open 175 degrees on concealed hinges. All assemblies shall be rustproof and exposed finished edges and surfaces shall be prime-coated with rust inhibitive paint. Doors to be installed in ceilings shall be with screw driver operated cam locks. Doors for wall installation shall have master-keyed cylinder locks. Doors shall be Milcor, or equal, as follows:

1.	Construction	Milcor Model
	a. Masonry	Style M
	b. Plaster	Style K

1.9 CLEANING OF SYSTEMS:

- A. The Contractors shall thoroughly clean all pipe and ductwork systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.
- B. All strainers shall be opened and cleaned thoroughly.
- C. The interior of all air handling equipment, ductwork and all filters shall be cleaned thoroughly before the building is accepted by the Owner.
- D. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.10 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.
- B. Three copies of factory maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.11 SUBSTITUTIONS:

- A. Various items of equipment and materials that have been used as the basis for mechanical system design have been specified by a manufacturer's name and model number. Another manufacturer's product may be submitted for consideration as a substitute. The Architect shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each of the Contractor's substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation. It shall be the responsibility of the Contractor to make certain that substitute equipment, which has been accepted by the Architect will fit into the designated spaces. He shall

make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing. Substitutions include all manufacturers that are not listed specifically by name on the drawings, even those listed as “approved equals” in the specifications.

1.12 ALTERNATES:

- A. Various items of equipment and materials that have been used as a basis for mechanical system design have been specified by a manufacturer's name and model number. Where another manufacturer's product has been specified as an alternate to this equipment the proposed cost for this alternate shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports and supporting structure, fittings, ductwork, motors, controls, electrical wiring and thermal insulation. It shall be the responsibility of the contractor to make certain the alternate equipment will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.

1.13 ALIGNMENT:

- A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.
- B. The Mechanical and Electrical Contractors shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.14 TEMPORARY HEAT:

- A. Requirements for providing temporary heat are stated in the General Conditions of the Specifications. New HVAC equipment furnished under this Contract may be used for temporary heat provided all of the following conditions are met:
 - 1. The HVAC equipment is installed as part of the permanent HVAC systems as indicated on the Drawings.
 - 2. The Contractor unconditionally extends the manufacturer's warranty one year from the date of final acceptance by the Owner.
 - 3. Air Handling systems, including air handlers, fan-powered boxes, etc. and duct distribution systems are not to be utilized for temporary heat until interior

- construction is substantially complete as determined by the Engineer. Obtain approval in writing.
4. The manufacturers of units with compressors extend the 5 year compressor warranty to start from the date of final acceptance by the owner.

1.15 RULES AND REGULATIONS

- A. All work shall be performed in accordance with the rules and regulations of Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.
- B. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.
- C. The Owner will obtain the building permit. Any other fees relative to the contractors work shall be paid by the contractor as part of his Bid.

1.16 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT, AND MATERIALS

- A. The Contractor shall submit, with a letter of transmittal to the Architect, PDF file type shop drawings containing all capacities, performances, features, options, accessories and technical data of all materials and equipment listed herein. All submittals shall be made within 45 days after awarding of the contract.
- B. Refer to Division 1.
- C. All disapproved submittals shall be corrected as directed by the Architect and resubmitted until approved within 30 days after the original submittal was disapproved. No work involving any materials or equipment covered by shop drawings shall be started until the respective shop drawings are approved.
- D. None of the items listed under Section 1.02 shall be installed until final approval has been given by the Architect.
- E. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number and specification section number, as appropriate on shop drawings.
- F. On shop drawings, apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Work and Contractor Documents.
- G. On shop drawings, provide space for Contractor and Architect/Engineer review stamps.

- H. Contractors shall include with each submittal/shop drawing, a matrix outlining all items that do not match the specified unit. If an item is not listed on the matrix, the submitted unit will be assumed to meet all parts of the specification. Contractors will be responsible to insure that the specifications are met in full. Items in matrix shall include schedule performance data vs submitted performance data, specified components vs submitted unit components, specified construction weight, warranty, etc. vs submitted construction, weight, warranty, etc.

1.17 VISIT TO THE SITE

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all cost and change made necessary by such conditions.

1.18 COORDINATION OF WORK

- A. Contractor shall coordinate his work with the of other trades. In case of interference or problems the Architect shall decide which work is to be relocated, regardless of which is installed first.

1.19 LOCATION OF EQUIPMENT

- A. All locations of plumbing, HVAC and fire protection equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.
- B. The Mechanical Contractor shall prepare dimensioned coordination/arrangement drawings at a scale of (1/4" = 1'0"). Layouts represented by these drawings shall be coordinated with all other trades.
- C. This Contractor shall obtain Architect approval of all arrangement drawings before continuing his work.

1.20 MATERIALS AND EQUIPMENT

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on this project. Samples shall be submitted for approval Architect prior to their installation.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.21 WORKMANSHIP

- A. All workmanship shall be done according to the best practices of the trade by qualified and competent tradesmen.

1.22 PROTECTION OF EQUIPMENT

- A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- B. He shall schedule material and systems for delivery in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.
- C. This Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.23 SCAFFOLDING AND HOISTING

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.24 FOREMAN

- A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.25 EXCAVATION AND BACKFILL

- A. The Contractor shall do all excavation and backfilling and all shoring, sheeting, pumping, all other work incidental to excavating as required for his installation.

- B. Backfill shall be made with clear earth; free from rocks, frozen earth, debris, or other foreign materials. Backfill shall be deposited in uniform layers of not over 8" thick and each layer shall be mechanically tamped before the next layer is applied.
- C. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.
- D. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.
- E. All ditching, pumping, canvas covers, and other methods required to protect and keep all excavation and trenches free from water at all times during the construction period shall be furnished, installed, and maintained by the Contractor.
- F. If the trench bottom becomes muddy, all mud shall be removed and replaced by bankrun sand and gravel or other suitable material as approved by Architect, and compacted to the density of the surrounding undisturbed soil. Bottom of trench shall be protected against frost or freezing. This Contractor shall provide adequate shoring to protect his and other workmen. Shoring shall be maintained until tests of lines is completed.
- G. Trenches that pass under paving or roads have less than 2' of cover, shall have a load-relieving slab over the pipe. Trenches which pass under or within 18" of any wall foundation shall be backfilled with concrete mixes 1 part cement, 3 parts sand, and 5 parts coarse aggregate.
- H. All repair or macadam or concrete paving made necessary by work done under this contract shall be performed by Site Contractor at the expense of this Contractor. All such repairs shall match surrounding paving in materials and workmanship.
- I. All grading and seeding made necessary by work done under this contract shall be performed by the Site Contractor at the expense of this Contractor. Work shall comply with the Architectural Section of the Specifications.

1.26 PAINTING

- A. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted 1 prime coat and 2 coats of best quality oil paint of color as selected by the Architect.
- B. All grilles, louvers, etc. shall be furnished in a color as selected by the Architect unless specifically noted otherwise on the mechanical drawings and schedules. When requested by the Architect, the equipment shall be finished with a prime coat and then professionally painted in the field in a color selected by the Owner. The Contractor shall assume responsibility for all costs involved.
- C. All exposed ductwork and piping systems shall be paint-grip type and painted with a prime coat by the H.C. The G.C. shall provide finishing coat(s).

- D. Provide corrosion inhibiting prime coating on all ferrous materials.
- E. Paint all metal laid underground with one heavy coat of corrosion protective materials.

1.27 CUTTING AND PATCHING

- A. This Contractor shall be responsible for all cutting and patching required for installation of new work on this project. Cutting and patching methods shall conform to the requirements for new construction contained in other sections of this specification.
- B. Patching in surfaces that will remain visible when the project is finished shall be identical in appearance to the undisturbed surface and shall be performed by the G. C.
- C. Patches in fire rated walls, ceilings and floors shall maintain the fire rating of these barriers by the use of approved materials including special fire rated sealing compounds or material identical to the barrier materials. Refer to the Architectural Specifications for approved methods and materials.
- D. All cutting work to existing walls, floors and ceiling in occupied areas during a phase prior to construction in that area shall be patched in time to be occupied during the hours of the next school day.
- E. Contractor shall seal all ductwork and piping penetrations through walls and floors even if not fire rated.

1.28 CLEANING

- A. Upon completion of the installation, thoroughly purge all piping of all obstruction and scale and adequately flush all liquid carrying piping to assure a clean system. Flush and treat all systems in each phase as required to meet phasing requirements.
- B. Wash all fixtures with soap and water, remove labels and protective covering and clean all grease and cutting from plates or polished piping and trim.
- C. Where damage to finish, furnishing or parts of the building results from pipe stoppage or from failure to clear and flush piping systems properly, the Contractor shall at his own expense, employ qualified skilled labor to make repairs.

1.29 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall prepare for the Owner, 3 hard bound volumes, each containing all operating instructions and information necessary for the care and maintenance of the system. These volumes shall be complete in every respect, and shall include detailed operating instructions for each piece of equipment and diagrams for control wiring and

piping so arranged and detailed that the maintenance staff may trace the control in even operational malfunctioning.

- B. The Contractor shall submit 1 of the hard bound volumes to the Architect for approval prior to presenting same to Owner.
- C. Printed instructions covering the operating and maintenance of each item of equipment shall be posted at locations designated by the Architect.
- D. The Contractor shall provide Project Records Documents in accordance with requirements of Division 1.

1.30 INSTRUCTION OF EMPLOYEES

- A. At the completion of the work this Contractor shall instruct the employees who shall have charge of the equipment in the care, adjustment, and operational of all parts of the system.
- B. At the time designated by the Architect, the equipment manufacturer's engineer shall instruct representatives of the Owner in the operation and maintenance of the equipment.

1.31 GUARANTEE

- A. All work done under these contracts shall be guaranteed by the respective contractors against defective materials and faulty workmanship for a period of 2 years from the date of substantial completion.
- B. During such a period, and before the expiration of each such guarantee, contractor shall agree to make any and all repairs, adjustments, or replacements which may become necessary, owing to initial settlement or shrinkage, defective material, workmanship, or installation. He shall perform all routine maintenance in accordance with the equipment manufacturer requirements.
- C. He shall further agree to provide all labor and material which may be required and to restore to its original condition any adjacent work that he may disturb in making the necessary repairs, adjustments, or replacements in order to fulfill this guarantee.
- D. Compressors shall have a 5 year guarantee.

1.32 GENERAL NOTE

- A. The HVAC Contractor shall replace filters in all new air handlers, rooftop units, unit ventilators, and cabinet heaters at the date of final completion of each phase. Up until that time, filters in all units shall be changed as necessary if the units are started and used prior to end of the phase. Provide a schedule of recommended filter change

intervals and filter sizes for all equipment to the Owner, and review locations of all filters with the Owner's custodial and maintenance staff prior to turn over of each phase.

PART 2 – PRODUCTS

2.1 NOT USED

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install equipment to permit removal of components and parts which require periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, gauges, starters, motors, doors and access panels.
- B. Provide access panels in equipment, ducts, etc. as required for inspection and maintenance.

3.2 PIPING INSTALLATION

- A. In general, piping shall be exposed in equipment rooms, and concealed in all finished rooms. Where piping is exposed, it shall be run so as to allow maximum headroom consistent with proper pitch. No piping or ductwork shall cross below the head of any window or door.
- B. Exposed piping, ducts, conduits, and/or appurtenances indicated on the inside of buildings, shall be installed parallel to the building lines. All piping shall be kept as close as possible to the ceilings, walls, and columns, to take up the minimum amount of space.
- C. All work shall be arranged and installed as high as possible to prevent obstruction of window areas, and to give adequate clearance and access for operation and maintenance.

3.3 SLEEVES

- A. Where pipes pass through concrete or masonry walls or concrete floors, they shall be protected through the full depth of the construction with galvanized sleeves; same to be at least one size larger than the pipe plus insulation.
- B. Where sleeves occur in concrete floors, the top of sleeve shall be flush with finished floor line, and the end shall be filed to a smooth round finish.

- C. This Contractor shall supply all pipe sleeve and shall inform general contractor of exact sleeve locations in time for their incorporation onto the concrete forms or masonry work.
- D. Any cutting and patching in masonry or concrete made necessary by failure to adequately coordinate with the general contractor shall be done by the general contractor at the expense of this contractor.
- E. The space between pipes and sleeves shall be caulked air tight with a non-combustible inorganic material.

3.4 UNIONS

- A. Unions shall be provided at all connections to each piece of equipment and on both sides of all automatic valves, and devices which require removal for maintenance. No unions are to be placed in a location which will be inaccessible after the completion of the project.
- B. Unions of copper tubing shall be 200 lbs. SWP brass ground joint.
- C. Unions for steel pipe shall be 250 lbs. SWP, malleable iron with brass to iron seat.

3.5 CLEARANCE

- A. All piping, including valves and fittings shall be installed to provide the following minimum clearances between the finish coverings, adjacent pipe and/or conduits: 2" between for piping services and 6" between piping services and electrical conduits.
- B. All soil, vent and waste stacks shall be increased to a minimum of 3" in size immediately before such pipes extend through the roof. Unless noted otherwise on drawings, all stacks extending through the roof shall finish at least 12" above the roof level.
- C. Furnish and install absorbers where required for proper system operation.

3.6 ESCUTCHEON PLATES

- A. All piping passing through walls, ceilings, and floors shall be provided with escutcheon plates securely fastened in place. Where installed on piping in finished areas they shall be chrome plated.

3.7 ACCESS PANELS

- A. Removable panels shall be located so as to provide easy access to all concealed plumbing accessories that may require adjustments or maintenance, such as valves, water hammer arresters, traps, strainers, cleanouts or others.

- B. Access panels in finished wall or ceiling surfaces shall be furnished by this Contractor for installation by the General Contractor.
- C. This Contractor shall pay for any work made necessary by his failure to inform other trades of access panel locations.

3.8 APPLICATIONS OF INSULATION AND COVERING

- A. No covering shall be installed by the Contractor until the piping and ducts have been approved by the Architect/Engineer.

3.9 PIPING UNDER FLOORS

- A. Wherever piping, conduits and associated materials is run under a floor slab on grade, the work is to be installed after the sub-grade has been brought to the proper level. The work shall then be installed and backfilled, allowed to settle, and refilled before placing crushed stone fill.

3.10 INSERTS

- A. Except as noted, provide box type inserts for all hangers and supports intended to suspend piping or light weight equipment from new concrete construction. Fasten all inserts of the form work before concrete is poured. Inserts to be Grinnell Figure No. 282 or Figure No. 279 depending upon the maximum load to be carried.
- B. No toggle bolts, expansion screw anchors or similar imbedded hanger supports shall be used in new construction.

3.11 CHASES AND OPENINGS IN FLOORS AND WALLS

- A. It shall be the duty of the Contractor requiring chases, openings or the placement of any sleeves, anchors, and supports required for his work, whether or not shown on the drawings, to advise the General Contractor accordingly, prior to or at the time of pouring concrete slabs, beams or the building of walls, etc. He shall furnish all such sleeves, anchors, and supports in place, and all necessary information for the proper location of said chases or openings.
- B. If a contractor shall fail to observe and comply with those requirements, he shall cut, at his own expense, after receiving the consent of the Architect, such chases or opening as may be necessary and proper, providing and building in place all lintels required by these openings, doing the necessary patching and rebuilding of the work required under the direction of the General Contractor and he shall be responsible for all loss or delay resulting therefrom.

3.12 LUBRICATION

- A. The contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall run in all bearings and, after they are run in drain all oil from the bearings, flush out all bearings, and refill with new oil. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The contractor shall be required to protect all bearings during installation and shall thoroughly grease steel shafts to prevent corrosion. All motors and other equipment shall be provided with covers as required for proper protection during construction.

3.13 EQUIPMENT BASES AND SUPPORTS:

- A. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- B. Construct supports of steel members. Brace and fasten and flanges bolted to structure.
- C. Provide rigid anchors for pipes after vibration isolation components are installed.

END OF SECTION 230501

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 RELATED SECTIONS

- A. Section 23 0514 - Adjustable Frequency Drives.

1.3 REFERENCES

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- D. ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.5 QUALITY ASSURANCE

- A. Conform to NFPA 70.
- B. Motors shall comply with ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings current edition.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Century
- B. Baldor
- C. Lincoln Motors
- D. A. O. Smith Electrical Products Company

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 40 degrees C environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 4. All motors shall be high efficiency type.
- B. Provide motors with phase loss protection.
- C. Mechanical Contractor shall provide all motors that are required. Each motor shall be the correct service type and have a horsepower rating that is adequate for the device it is intended to drive. Motors shall not exceed their full load rating, including the service factor rating, whenever the driven equipment is operating at the specified capacity under normal operating conditions.
- D. Insulation shall be Class B. Motors shall be drip-proof in dry, non-hazardous locations, weather protected where exposed to the weather or dampness, and totally enclosed, fan cooled where specified. Drip-proof and totally enclosed fan cooled motors, fractional and integral horsepower, shall have service factor ratings of 1.15 and 1.0 respectively. Fractional horsepower motors shall have sealed, permanently lubricated, ball bearings unless sleeve bearings are standard with a manufacture of equipment which utilized direct driven fans. Integral horsepower motors shall have ball bearings with grease zerks fittings and drain ports. All motors shall be rated for continuous duty. Maximum temperature rise shall not exceed 40 degrees C. for drip-proof frame motors and 55 degrees C. for totally enclosed motors in a 40 degree C. ambient condition. Motors shall be suitable for the electrical service specified, scheduled or shown.
- E. Motors shall have been tested and approved by the Underwriters' Laboratories, Inc. Motors shall be manufactured and classified in accordance with the current NEMA Standard Publication No. Mg 1 entitled "Motors and Generators."
- F. Motors shall be dynamically balanced and tested at the factory before shipment. They shall be relatively quiet while running. Connections to direct driven devices shall be made with a flexible coupling. Motors for V-belt drive service shall be furnished with a steel base and a screw device for adjusting belt tension.
- G. Motors shall be mounted so that they are readily accessible for maintenance. Motor terminal boxes shall be accessible. Covers shall not be blocked by other equipment. Watertight terminal boxes shall be provided on those motors in wet locations or where they are exposed to the weather. Motor mounting arrangement shall be such that the motor mounting bolts are accessible in order to facilitate its removal.
- H. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- I. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

J. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.3 ELECTRICAL CONNECTIONS

- A. All electrical connections shall be made by the Electrical Contractor. Motors and controls for equipment furnished by each Contractor shall be furnished and set by the Contractor furnishing the equipment. Where electrical work is specifically indicated to be performed by the Plumbing, Fire Protection or Heating Contractor, this Contractor shall perform the work in conformance with Electrical Specifications for this projects.

2.4 MOTOR CONTROLLERS

- A. Mechanical Contractor shall provide motor controllers. The items shall be products of one manufacturer, Allen-Bradley, Square D, General Electric or Westinghouse, and shall meet latest N.E.M.A. and IEEE Specifications. Starters and contactors shall be horsepower rated. Starters shall include the proper size heater elements
- B. Magnetic starters used with pressure or float switches, thermostats or similar maintained contact switches shall be provided with "On-Off-Auto" switches on the starter.
- C. Unless otherwise noted, control and pilot devices such as electric thermostats, alternators, float controls, aquastats, etc., shall be furnished and installed by the Mechanical Contractor. Each device shall be provided with all auxiliary features and accessories which may be required for correct operation of the associated equipment.
- D. Magnetic starters shall be provided with start-stop pushbuttons on the starters unless remote control pushbuttons or other methods of starting are specified elsewhere.
- E. Unless otherwise noted elsewhere, all magnetic motor starters controlled with a remote pilot device shall contain a control circuit transformers, as an integral part of the controller, providing control power at a maximum 120 volts for the pilot device. The exact control circuit voltage shall be coordinated with the ATC supplier prior to the purchase of any motor controllers.
- F. Starters and protective devices which are provided as an integral part of the equipment furnished under the Mechanical Contracts, shall be supplied.

- G. For use in manual starting of fractional horsepower motors up to but not including 1/2 horsepower, the Mechanical Contractor shall furnish a thermal manual toggle switch type starter with pilot light specifically designed for this purpose. Each starter shall be provided with proper size heater element for the motor to be controlled. Heater elements shall be readily removable and interchangeable. Starters shall be arranged for flush or surface mounting as indicated or as required.
- H. Controllers and wiring diagrams shall be delivered to the Electrical Contractor.

2.5 MOTOR DISCONNECTS:

- A. Unless otherwise noted, motors located out of sight of their respective electric panels shall be provided with disconnect switches at the motors by the Electrical Contractor.
- B. All exhaust and supply fans on the roof shall be provided with disconnecting means at the motors as an integral part of the equipment.

2.6 ENCLOSURES:

- A. Motor controllers and disconnects shall be provided with standard approved enclosures to suit the locations in which they are installed and the conditions under which they are to operate.

2.7 MOTOR CONTROL WIRING:

- A. The Electrical Contractor shall run the power wiring system from the various supply panels indicated, to the motors and motor controllers and shall make final connections unless otherwise noted on the Drawings. The Mechanical Contractors shall run all control wiring from the motor controllers to the pilot devices.
- B. Starters, and protective control devices which are provided as integral part of the motors or motor-operated equipment shall be prewired at the factory.
- C. After final connections are completed, the Mechanical Contractor shall test each motor for proper rotation. Before applying current to the motor, the Mechanical Contractor shall check the motor for alignment, oil, etc. The Mechanical Contractor shall make any necessary adjustments to the starter and control equipment for proper starting and overload protection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.
- D. All electrical work provided by this contractor shall comply with the electrical contract specifications.
- E. Motors:
 - 1. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
 - 2. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 230513

SECTION 230514 - ADJUSTABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of the Contract, including General and Supplementary Conditions apply to the Work of this Section.
- B. Section 23 0993 - HVAC Control Sequence.
- C. Section 23 0923 – Automatic Temperature Controls

1.2 DESCRIPTION OF WORK:

- A. Extent of work is hereby defined as the furnishing and installation of adjustable frequency drives of the types and sizes as indicated on the Drawings and as specified herein.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Subject to compliance with the requirements of this section, provide adjustable frequency drives as manufactured by Magnatek, Square D, Cutler Hammer, ABB, or Danfoss.
- B. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 70 "National Electric Code", pertaining to the construction and installation of electrically operated components.
- C. NEMA Compliance: Comply with applicable provisions of NEMA Standards pertaining to motor starters, control panels, and wiring devices.
- D. UL Compliance: Provide electrical components which have been tested, approved, and labeled by Underwriters Laboratories.

1.4 SUBMITTALS:

- A. Division 1 contains definitions, requirements and procedures for the following submittals:
 - 1. Shop Drawings
 - 2. Guarantees
 - 3. Product Data

1.5 WARRANTY:

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES:

- A. General: Provide adjustable frequency drives (AFD) for equipment as scheduled to vary the speed of the three phase AC motors to proportionately control the air flow of each system. The AFD shall utilize a 16-bit microprocessor for sine-coded pulse width modulation of AC induction or synchronous motors.
- B. Input Power: The AFD shall accept scheduled input voltage within a $\pm 10\%$ variation.
- C. Output Power: The AFD output power shall vary frequency to the motor from 0 to 400 Hz with resultant motor speed varying at the motor nameplate rated speed, with output voltage variation from zero to motor rated voltage for optimum volts per hertz (V/Hz) ratio for fan loads. Output currents shall be rated 125% of motor full load amps for 1 minute based upon AFD's variable torque rating. The output shall be a voltage source type generating a sine coded PWM waveform utilizing an asynchronous carrier frequency up to 15000 Hz. The carrier frequency shall be adjustable to minimize harmonically induced noise or vibration.
- D. Power Structure: The AFD power input stage shall convert three phase AC line power to a fixed DC bus voltage by using a full-wave diode rectifier with three phase protection. Power factor shall be .98 or corrected with capacitors. The AFD shall have power component monitoring/protection, short circuit power protection, and capacitive filtering of DC power. Switching transistors shall convert DC power to sine coded pulse width modulation voltage for motor control. Current transformers shall monitor output current and be used by the microprocessor for: thermal overload protection, three phase current limit, ground fault and short circuit protection, and motor restart with speed search. Insulated Gate Bipolar Transistors shall be utilized for a fixed carrier frequency of 15,000 Hz.
- E. Operation and Protective Functions: The AFD shall be capable of performing the following operational functions in addition to providing built-in protective features:
 - 1. DC injection braking with adjustable start frequency, current limit and time duration to provide braking before fan start-up.
 - 2. Programmable critical frequency interruptive to lock-out up to 3 frequency ranges, 0 to 10 Hz, to avoid motor operation at resonant speeds.
 - 3. Speed search to restart motor while fan is still rotating.
 - 4. Reference speed loss detection to continue fan operation if the reference frequency is interrupted. Motor shall be operated at 80% of last reference value.
 - 5. Programmable auto restart and stall prevention to adjust output frequency to avoid overload or overcurrent conditions.

6. Power-loss ride through to automatically restart the motor after a power interruption less than two seconds duration.
 7. Reverse rotation prevention.
- F. Control Terminal Functions: A control terminal strip shall be provided to accept the following external control commands:
1. Forward Run/Stop to initiate or stop AFD operation.
 2. Speed Reference Input to accept an instrument follower signal of either a) 0 to 10 VDC, b) 4 to 20mA, or c) 1 to 5 VDC as determined by the Automatic Temperature Control Contractor.
- G. Multi-function output contacts programmable for any of the following indications:
1. Run mode
 2. Zero speed detect
 3. Over-torque detect
 4. Coast to stop detect
 5. Run reference mode
 6. Speed reference mode
 7. Speed synchronization
 8. Output frequency detect
 9. Low voltage detect
 10. Operation ready
 11. Speed reference loss detect
 12. Braking resistor fault
 13. Drive fault
 14. Output fault relay contact to indicate AFD diagnostic fault detection.
 15. Terminal for HOA switching.
 16. Input terminal to shut down motor operation on smoke detection signal or other external fault signals.
 17. Analog output signal, 0 to 10 VDC, proportional to output frequency or output covered.
- H. Local Operator Control: The AFD shall have a front mounted sealed touch-pad operator to include:
1. Local run/stop keys
 2. Local speed command
 3. Reset push button
 4. Digital output frequency meter and speed reference meter which both can be reprogrammed for other speed related indications, including RPM, CFM, FPM, etc.
 5. Digital voltmeter.
 6. Digital kilowattmeter.
 7. Digital ammeter.
 8. Input and output terminal status indication.
 9. Ability to program various control functions without necessity of stopping drive while in Run mode, including but not limited to the following:

- a. Acceleration and deceleration
- b. Frequency command bias and gain
- c. Torque compensation
- d. Slip compensation
- e. Energy savings gain
- f. Multi-step speed references
- g. Digital diagnostic indication and protection for:
 - 1) DC bus undervoltage
 - 2) DC bus over voltage
 - 3) Load over torque
 - 4) Fuse blown
 - 5) Motor overload
 - 6) AFD overload
 - 7) Heatsink over temperature
 - 8) Instantaneous over current
 - 9) Operator error
 - 10) Central processor fault
 - 11) External fault
 - 12) Dynamic braking fault

I. AFD Adjustments: The microprocessor control AFD logic shall include the following adjustments:

- 1. Maximum output frequency - 0 to 400 Hz.
- 2. Minimum output frequency - 0 to 400 Hz.
- 3. Acceleration time - .1 to 6000 seconds.
- 4. Deceleration time - .1 to 6000 seconds.
- 5. Current limit - 0 to 170%.
- 6. 15V/Hz pre-set selection patterns.
- 7. Capability to program a totally customized V/Hz pattern.
- 8. Auto speed reference (instrument follower) input adjustable for bias and gain.
- 9. Stall prevention accomplished by reducing output voltage and frequency during momentary overload. When overload clears, drive will automatically resume normal operation.
- 10. Adjustable torque and/or current limit.
- 11. Ramp to stop or coast to stop selection.
- 12. Capability to set upper and lower frequency limits independent of min and max V/Hz frequency patterns.
- 13. Linear or S-curve function for soft start.
- 14. Two independent, selectable accel/decel ramp functions.
- 15. A minimum of 4 programmable multi-function inputs.
- 16. External start/stop shall be programmable for either 2 wire or 3 wire control. 3 wire option should not require a holding contact.
- 17. There shall be a programmable lock out code available to prevent operator access to parameter setting.
- 18. A selectable/adjustable energy saving gain shall be available that can be activated during frequency command synchronization.
- 19. Minimum of 9 preset speeds.

20. Up/down frequency setting.

- J. Bypass: The VFD shall have a bypass to allow operating the connected motor in the event of VFD failure.
- K. Systems Integration: AFD manufacturer shall provide Lon Works and BACNET network card to interface with BAS system.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install all equipment listed in this section in accordance with the manufacturer's written instructions and wiring diagrams or as directed by factory service personnel.

3.2 START-UP:

- A. Do not place AFD's into start-up until mechanical and electrical systems are fully operational including installation of terminal equipment and automatic temperature controls.
- B. The AFD manufacturer's factory trained service personnel shall perform all programming and start-up procedures.
- C. Instruct Owner on operation of unit. Provide minimum 4 hours instruction.

3.3 TESTING AND ADJUSTING:

- A. The manufacturers factory trained service personnel shall test each unit through the full range of operation including checking all input/output signals, and fault conditions.
- B. Manufacturer shall validate system is fully functional and operation perfectly upon completion of testing and adjusting.

END OF SECTION 230514

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SECTION 230515 - REMOVALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION OF WORK:

- A. This Contractor shall be responsible for the removal of existing piping, fixtures, ductwork or equipment in the existing building which is shown on the Drawings or which is in conflict with the new construction or new mechanical systems. Existing piping, equipment and ductwork which are removed shall be disconnected at their source and capped. Furnish all labor, equipment hauling, rigging, scaffolding, etc. necessary for the removal phase of the project.

1.3 GENERAL:

- A. Existing piping, fixtures, equipment, ductwork and related accessories which require systems to be shut-down shall be coordinated with the Owner. Periods of shut-down shall be minimal and all new work shall be planned and scheduled to accomplish as few shut-downs as possible.
- B. All construction and removal work shall be performed in a manner as to keep the existing systems in operation as the work progresses. Prior to commencing construction, the contractor shall review the construction schedule with the Owner and Architect to assure a well-coordinated schedule.
- C. Cutting and patching in concealed locations shall be by this Contractor unless otherwise indicated.
- D. Cutting and patching in exposed locations shall be by the General Contractor.
- E. The Owner shall have the option of keeping any or all salvageable items removed from building such as draft barriers, unit ventilators, cabinet heaters plumbing fixtures, etc. Any items removed from the building that Owner does not wish to keep shall become the property of this Contractor and he shall dispose of these items.

END OF SECTION 230515

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SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Pipe loops, offsets, and swing joints.

1.2 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 23 00 - Refrigerant Piping.

1.3 REFERENCE STANDARDS

- A. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2013.
- B. EJMA (STDS) - EJMA Standards; Expansion Joint Manufacturers Association; Ninth Edition.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- C. Design Data: Indicate selection calculations.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- F. Maintenance Data: Include adjustment instructions.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. Manufacturers:

1. Metraflex Company: www.metraflex.com.
2. Mason Industries, Inc.
3. Flexonics.
4. Keflex.

B. Inner Hose: Carbon Steel.

C. Exterior Sleeve: Single braided, stainless steel.

D. Pressure Rating: 125 psi and 450 degrees F.

E. Joint: As specified for pipe joints.

F. Size: Use pipe sized units.

G. Maximum offset: 3/4 inch on each side of installed center line.

2.2 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturer:

1. Metraflex Company: www.metraflex.com.
2. Mason Industries, Inc.
3. Flexonics.

B. Inner Hose: Bronze.

C. Exterior Sleeve: Braided bronze.

D. Pressure Rating: 125 psi and 450 degrees F.

E. Joint: As specified for pipe joints.

F. Size: Use pipe sized units.

G. Maximum offset: 3/4 inch on each side of installed center line.

2.3 EXPANSION LOOPS

A. Manufacturers:

1. Metraflex Company: www.metraflex.com.
2. Mason Industries, Inc.
3. Flexonics.
4. Keflex.

B. Metraloop with two sections of hose and braid, two 90 degree elbows, and 180 degree return.

C. Install within 4 pipe diameters of alignment guide.

D. Pipe material shall match service pipe.

2.4 ACCESSORIES

A. Pipe Alignment Guides:

1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.

B. Swivel Joints:

1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.

C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.

D. Anchor pipe to building structure where required. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

- E. Provide support and equipment required to control expansion and contraction of piping.
Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION 230516

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1- GENERAL

1.1 SECTION INCLUDES

- A. Pressure gages and pressure gage taps.
- B. Thermometers and thermometer wells.
- C. Static pressure gages.

1.2 RELATED SECTIONS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 09 23 - Automatic Temperature Controls.
- C. Section 23 09 93 - HVAC Control Sequence.

1.3 REFERENCES

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2005.
- B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi; The American Society of Mechanical Engineers; 2007.
- C. ASTM E 1 - Standard Specification for ASTM Thermometers; 2007.
- D. ASTM E 77 - Standard Test Method for Inspection and Verification of Thermometers; 2007.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.
- B. Do not use mercury filled thermometers.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

- A. Manufacturers:
 - 1. Moeller Instrument Co., Inc: www.moellerinstrument.com.
 - 2. American.
 - 3. Terice.
 - 4. Weksler.
- B. Gage: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi and KPa.

2.2 PRESSURE GAGE TAPPINGS

- A. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.3 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Moeller Instrument Co., IncNone - N/A: www.moellerinstrument.com.
 - 2. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 - 3. American.
 - 4. Terice.

- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

1. Size: 9 inch scale.
2. Window: Clear glass.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F and Degrees C.

2.4 DIAL THERMOMETERS

- A. Manufacturers:

1. Moeller Instrument Co., Inc. None - N/A: www.moellerinstrument.com.
2. Weksler Glass Thermometer Corp: www.wekslerglass.com.
3. American.
4. Weksler.

- B. Thermometer: ASTM E 1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.

1. Size: 3 inch diameter dial.
2. Lens: Clear glass.
3. Accuracy: 1 percent.
4. Calibration: Degrees F and Degrees C.

2.5 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nardel core for temperatures up to 350 degrees F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- D. Install thermometers in air duct systems on flanges.
- E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 23 09 23. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- F. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- G. Coil and conceal excess capillary on remote element instruments.
- H. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- I. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- J. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- K. Locate test plugs adjacent thermometers and thermometer sockets, pressure gauges and pressure gage taps, and where indicated.

END OF SECTION 230519

SECTION 230549 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SUMMARY:

- A. The extent of vibration isolation work is indicated by Drawings and schedules and by requirements of this Section.
- B. The types of vibration isolation specified in this Section include the following:
 - 1. Support isolation for motor driven Mechanical Equipment.
 - 2. Support isolation for piping and piping risers.
 - 3. Flexible connections for piping at Equipment.
 - 4. Flexible ductwork connections.

1.2 SUBMITTALS:

- A. Comply with pertinent provisions of Division 1.
- B. The Manufacturer of vibration isolation products shall submit the following data clearly marked on the submittal drawing. Each piece of isolated equipment shall be clearly identified, as well as the quantity and type of vibration isolators.
 - 1. Weight and center of gravity of each piece of isolation equipment, and RPM of each piece of rotating isolated equipment. When equipment center of gravity is not available, assumed locations for center of gravity shall be identified in submittals.
 - 2. Calculated static load on each isolator.
 - 3. Calculated deflection for each piece of isolated equipment.
- C. Submittals for mountings and hangers incorporating springs shall include spring diameters, rated deflections, spring free height, solid spring height and spring color code.
- D. Submittals for bases shall clearly identify locations for all mountings, as well as all locations for attachment points of the equipment to be mounting base. Installation instructions shall be included.

1.3 QUALITY ASSURANCE:

- A. Product Qualification: Provide each type of vibration isolation unit produced by a specialized manufacturer, with not less than 5 years successful experience in the production of units similar to those for the project.

1. Except as otherwise indicated obtain support isolation units from a single manufacturer.
 2. Engage the manufacturer to provide technical supervision of the installation of support isolation units produced by him, and of associated inertia bases.
- B. Manufacturer: Provide vibration isolation and seismic mounting units manufactured by the following:
1. Amber/Booth
 2. Consolidated Kinetics Corp.
 3. Vibration Mountings and Controls, Inc./Korfund Dynamics
 4. Mason Industries
 5. Vibration Eliminator Co.
- C. After installation is complete and while the system is operating, the vibration isolation Manufacturer and/or his qualified Representative shall conduct an inspection of the installation with the Contractor. The Representative will submit a written inspection report detailing any discrepancies, the Representative shall submit a report so stating. If there are discrepancies, the report shall detail corrective work to be done.

1.4 DESIGN - VIBRATION ISOLATION SYSTEMS:

- A. Vibration isolators shall be selected based on known or estimated operating weight distributions of the isolated equipment, with the quantity and location as shown on the components drawings. Isolator type shall be tabulated for each isolated piece of equipment.
- B. Isolators shall have either known non-deflected heights of spring element or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified to determine if the load is within the proper range of the isolator and if the correct degree of vibration isolation is being provided.
- C. Isolators shall function in the linear portion of the load versus deflection curve. Theoretical vertical natural frequency shall not differ from the design objectives by more than +10%.
- D. Vibration isolation available internal to the equipment shall not be considered equivalent, and may only be used where it can be shown not to compromise the strength or performance of the entire system.
- E. Unless otherwise specified, all isolated equipment and all piping and ductwork shall be seismically restrained in accordance with requirements contained herein. All un-isolated mechanical equipment shall be adequately secured to the structure.

- F. Unless the equipment incorporates unit construction using an integral unit frame or is specified otherwise, each item of mechanical equipment, along with its drive unit, shall be mounted on a rigid steel or steel and concrete base. The equipment, including the base, shall be mounted on, or suspended from, vibration isolators to prevent the transmission of vibration and mechanically transmitted structure-borne sound to the supporting structure.
- G. Isolation hangers shall be used for all piping in equipment rooms or for 50 ft. from vibration equipment, whichever is greater. To avoid reducing the effectiveness of equipment isolators, at least three of the first hangers from the equipment should provide the same deflection as the equipment isolators, with a maximum limitation of 2 inch deflection. The remaining hangers shall be spring or combination spring and rubber with a minimum of 0.75 in deflection. To prevent load transfer to the equipment flanges when the piping system is filled, the first three hangers adjacent to the equipment shall be the positioning type (specification type 5). Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use restrained vibration isolators. They should be selected according to the guidelines for hangers.

PART 2 - PRODUCTS

- 2.1 Unless otherwise specified, all hardware shall be stainless steel or zinc plated. Springs with a deflection of up to 2" shall be zinc plated or coated with a polyester epoxy powder. Springs with a rated deflection capability greater than 2" may be painted. Zinc plating shall conform to ASTM B633, Class 2 SC2, Minimum.
- 2.2 TYPE 1 MOUNTINGS - DOUBLE DEFLECTION NEOPRENE:
 - A. Double deflection neoprene mountings shall have a minimum rated static deflection of 0.40 inches. Steel top plate and base plate shall be completely bonded and embedded in oil-resistant elastomer. Mountings shall be molded in color for ease of identification of load capacity, and shall have ribbed neoprene surfaces on top and bottom to provide friction pads for those applications which do not need to be bolted to the floor or to equipment. Bolt holes shall be provided on the bottom plate, and a tapped hole on the top, for applications requiring positive tie down.
 - B. Mountings may be combined with steel rails for ease of installation, to compensate for overhung components or for equipment which lack sufficient rigidity for point support.
 - C. Neoprene mountings shall be type RD and steel channel rails type DRB as manufactured by Vibration Mountings and Controls, Inc.

2.3 TYPE 2 MOUNTINGS - FLOOR MOUNTED SPRING ISOLATORS:

- A. Free standing spring-type isolators, shall be laterally stable without housing, snubbers, or guides, and shall include a steel reinforced, ribbed neoprene cup (1/4-inch minimum thickness) between the baseplate and the support.
- B. Mountings shall have leveling bolts on the top, consisting of an adjusting bolt, cap screw and washer. Mountings shall include a bolt hole in the bottom cup or a two hole rectangular steel baseplate for bolting to the structure. Springs shall not be welded to the baseplate or cup.
- C. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection.
- D. Springs shall have a ratio of horizontal stiffness to vertical stiffness of .75 to 1.25.
- E. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Springs having rated deflection greater than 2 inches may be painted. Hardware shall be stainless steel, or zinc plated.
- F. Housed floor isolators shall consist of a telescoping housing containing one or more steel springs as the isolating medium. Isolators shall include resilient inserts to act as upper and lower housing guides, and to prevent metal-to-metal contact providing elastomeric snubbing for side loads. A replaceable neoprene acoustical non-skid pad shall be attached to the bottom of the housing. Mountings shall have built-in leveling bolts and a minimum additional travel to solid equal to 50% of the rated deflection.
- G. Free standing Spring-Flex Mountings shall be Series AC, Series ACB, or Series AWHC as manufactured by Vibration Mountings and Controls, Inc. Housed Spring-Flex Mountings shall be Series B, C, or D as manufactured by Vibration Mountings and Controls, Inc.

2.4 TYPE 3 MOUNTINGS - HOUSED SPRINGS WITH LIMIT STOPS:

- A. Free standing, laterally stable spring-type isolators. Isolators is the same as described in Specification Type 2, except that it includes a housing to provide vertical limit stops to prevent spring extension during weight changes (e.g., draining of fluid from cooling towers and boilers), or when equipment (such as cooling towers) are exposed to uplift loads such as wind loading.
- B. The housing serves as blocking during erection, and shall be located between the equipment and supporting structure. Housing shall be painted or hot dip galvanized. There shall be a minimum clearance of 1/2 inch between the restraining bolts and the housing and spring to prevent interference with spring performance. Limit stops shall be out of contact during normal operation.

- C. Mountings shall have an adjusting bolt on the top of the spring compression plate. Neoprene acoustical non-skid pads (1/4 inch minimum thickness) shall be attached to the bottom plate.
- D. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection.
- E. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Springs having rated deflection greater than 2 inches may be painted. Hardware shall be stainless steel or zinc plated. Springs shall not be welded to the cups or housings.
- F. Spring-Flex Mountings shall be Series AWR as manufactured by Vibration Mountings and Controls, Inc.

2.5 TYPE 4 MOUNTINGS - SPRING AND RUBBER HANGERS:

- A. Spring-Flex hangers shall consist of a steel spring in series with a .2 inch (minimum) deflection neoprene element. Springs shall be color coded, and elastomer element molded in specific colors for proper identification of rated load capacity. The total static deflection at rated load shall be 1.20 inches.
- B. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- C. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- D. Spring-Flex hangers shall be series RSH as manufactured by Vibration Mountings and Controls, Inc.

2.6 TYPE 5 MOUNTINGS - SPRING AND RUBBER PRE-POSITIONING HANGERS:

- A. Spring-Flex hangers shall consist of color-coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Hanger design shall incorporate a means for supporting the suspended equipment or piping at a fixed elevation during installation regardless of load changes as well as a means for transferring the load to the spring.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Spring-Flex hangers shall be series RSHP positioning hangers as manufactured by Vibration Mountings and Controls, Inc.

2.7 TYPE 6 MOUNTINGS - SPRING AND RUBBER HANGERS WITH 30 DEGREE MISALIGNMENT CAPABILITY:

- A. Spring-Flex hangers shall consist of a color coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers which are to be used with flat iron duct straps will be provided with eye bolts on both ends.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Spring-Flex hangers shall be Series RSH-30A as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be type RSHSC as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be type RSHSC as manufactured by Vibration Mountings and Controls, Inc.

2.8 TYPE 7 MOUNTINGS - PRE-COMPRESSED HANGERS:

- A. Spring-Flex hangers shall consist of a color coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Springs shall be pre-compressed to the rated deflection so as to support the suspended equipment or piping at a fixed elevation during installation regardless of load changes. For 30 degree misalignment capability, spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Spring-Flex hangers shall be Series RSHPR or RSHPR-30A for 30 degree misalignment capability, as manufactured by Vibration Mountings and Controls, Inc.

2.9 TYPE 8 MOUNTINGS - SPRING HANGERS:

- A. Spring-Flex hangers shall consist of a color coded steel spring with a neoprene and steel washer which will properly distribute the load on the spring. For 30 degree misalignment capability, spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers where are to be used with flat iron duct straps will be provided with eye bolts on both ends.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

- C. Spring-Flex hangers shall be Series SH or SH-30A for 30 degree misalignment capability, as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be Type SHSC or SHSC-30A for 30 degree misalignment capability, as manufactured by Vibration Mountings and Controls, Inc.

2.10 TYPE 9 MOUNTINGS - HORIZONTAL THRUST RESTRAINTS:

- A. Horizontal Thrust Restraints shall be provided to prevent excessive movement of air handling equipment having air thrust which exceeds 10% of the unit weight. The horizontal thrust restraint shall consist of a steel housing containing a steel spring in series with a neoprene pad. The restraint assembly shall be designed to be pre-adjusted by the manufacturer and permit further adjustment in the field to limit horizontal movement to a maximum of 1/4 inch. Assembly shall be furnished with back up plates and hardware for attachment to both the equipment and ductwork or structure. Horizontal restraints shall be attached on the centerline of thrust on each side of the unit.
- B. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- D. Horizontal thrust restraints shall be Series HTR as manufactured by Vibration Mountings and Controls.

2.11 TYPE 10 MOUNTINGS - FLOOR, WALL, AND CEILING SLEEVES:

- A. Where piping passes through walls, floors, or ceilings, a vibration control sleeve shall be provided to reduce the transmission of vibration. The sleeve shall consist of two pipe halves with neoprene sponge material bonded to the inside and a bolting arrangement for secure fit around piping. Where temperature exceeds 240 degrees F., an appropriate density fiberglass shall be used in place of neoprene material.
- B. Sleeve shall be type VCS as manufactured by Vibration Mountings and Controls, Inc.

2.12 TYPE 11 MOUNTINGS - RESILIENT PIPE GUIDES:

- A. Where vertical piping runs between support points, a resilient pipe guide shall be provided. The guide shall consist of an angle frame and four double deflection neoprene mountings molded in specific colors for proper identification of rated load capacity.
- B. Resilient Pipe Guide shall be type RPG as manufactured by Vibration Mountings and Controls, Inc.

2.13 TYPE 12 MOUNTINGS - PIPE ANCHORS:

- A. Multi-directional pipe anchor shall consist of suitable steel sections in series with heavy duty duck and neoprene material assembled in a telescopic housing to provide the necessary restraint in both the vertical and horizontal directions. Pipe anchor shall be sized to limit load on neoprene and duck material to 500 psi.
- B. Multi-directional Pipe Anchor shall be type MDPA as manufactured by Vibration Mountings and Controls, Inc.
- C. Pipe anchors are not required for grooved piping with flexible couplings.

2.14 TYPE 13 - FLEXIBLE CONNECTORS:

- A. Install Quiet-Sphere Flexible Connectors at the suction and discharge of each pump and inlet and outlet of each chiller, condenser, boiler, cooling tower, and all floor mounted and inline pumps. The connectors shall be molded in spherical design of multiple layers of neoprene and synthetic fiber with integral corrosion resistant plate steel flanges. The connectors shall be suitable for pressures up to 214 psi and temperatures up to 240 degrees F. Where piping is not anchored, control rods must be installed at each connector to limit movement within their specified limits.
- B. Flexible connectors shall be Quiet-Sphere Type VMT, or VMU as manufactured by Vibration Mountings & Controls, Inc.

2.15 BASES AND RAILS:

A. TYPE C - CONCRETE INERTIA BASE:

- 1. Concrete Inertia Base Pouring Forms shall be of formed steel members with a depth not less than 1/12 of the longest base dimension, but not less than 6 inches. Height saving isolator mounting brackets shall be bolted or welded to the members. Pouring forms shall include minimum 3/8 inch concrete reinforcing steel (rebar) on 8 inch centers running the length and width of the base. Pouring forms for Split Case Pumps shall be wide enough to support suction and discharge elbows. Anchor bolt templates shall be provided to accept mounting hole location of the supported equipment. Bolted modular designs may be supplied for bases 6" or 10" thick.
- 2. Bases shall be Type MPF for Modular style or Type WPF for Welded style, as manufactured by Vibration Mountings & Controls, Inc.

B. TYPE D - ISOLATION ROOF CURB:

1. Curb mounted rooftop equipment shall be supported by isolation roof curbs. All plumbing and electrical connections to the equipment shall be flexible with water connections provided by double sphere neoprene union type flexible connections. The isolation curb shall consist of a rigid steel lower section containing properly spaced pockets with fully adjustable spring isolators. All springs shall be color coded for proper identification and spring pocket shall allow for easy removal or replacement of any spring without disturbance of the supported equipment. Spring pockets shall also contain combination vertical and horizontal restraint in conjunction with a 1/4 inch thick neoprene rubber bushing which will resist wind and seismic forces. All springs shall be installed in series with a 1/4 inch thick neoprene acoustical cup or pad. Hardware must be zinc plated and springs of 2 inch deflection or less shall be coated with a polyester epoxy powder. Springs above 2 inch deflection shall be provided with a rust resistant finish. Minimum spring deflection to be 1 inch. For units with a piping vestibule, the curb shall accommodate and mate with the piping vestibule.

PART 3 - EXECUTION

3.1 PERFORMANCE OF VIBRATION ISOLATORS:

- A. The manufacturer shall warrant the selection, sizing, and application of all vibration isolators for each application.

3.2 APPLICATIONS:

- A. General: Except as otherwise indicated, apply the following types of vibration isolators for the indicated items of Equipment.

3.3 VIBRATION ISOLATOR SCHEDULE

A. EQUIPMENT	TYPE	DEFLECTION
1. Chillers	13, 3	1.00
2. Split System Condensing Units	1	
3. Rooftop Air Handling Units/ERU/HRU	D	1.00
a. (Curb mounted rooftop)		
4. Air Handling Units	4	0.75
a. (Suspended, Up to 5 HP)		
b. In-Line Fans, Fan Coils,		
c. Cabinet Heaters (Suspended)		
5. Pumps, Base Mounted	C, 3, 13	1.00

B. Flexible Duct Connectors: Install at the following ductwork connections:

1. Connections with vibration-isolation-mounted air handling equipment.
2. Connections with fixed wall louvers for air intake and exhausts.

C. Flexible Pipe Connectors: Install in piping systems at the following locations:

1. Connections, 3/4" pipe size and larger, with vibration isolation mounted equipment.

3.4 INSTALLATION:

- A. Isolation systems shall be installed in strict accordance with the Manufacturer's written instructions and submittal data. Locations of all vibration isolation products shall be selected for ease of inspection and adjustment, as well as for proper operation. Electrical and plumbing connections to vibration isolated equipment shall be flexible.
- B. All vibration isolators shall be leveled and aligned squarely below the mounting points of the supported equipment. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft (generally, the long axis) unless this is not possible because of physical restraints.
- C. Unless otherwise indicated, there shall be a minimum operating clearance of 1 inch between inertia bases or structural steel frames and the concrete housekeeping pad or floor beneath the equipment. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.
- D. Vibration isolation hangers shall be positioned as high as possible in the hanger rod assembly, and so that the hanger housings may rotate a full 360 degrees without touching any object. Hanger rods shall not contact any object which would short out the vibration isolation systems. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Do not mix vibration isolated and non-vibration isolated pipes on the same trapeze.
- E. Attention must be paid to movements of piping caused by expansion and contraction.

3.5 EXAMINATION OF RELATED WORK:

- A. Installer of vibration isolation work shall observe the installation of other Work related to vibration isolation work, including work connected to vibration isolation work; and after completion of other related Work (but before Equipment startup), shall furnish a written report to the Engineer listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:

1. Equipment installations (performed as Work of other Sections) on vibration isolators.
 2. Piping connections including flexible connections.
 3. Ductwork connections including provisions for flexible connections.
 4. Passage of piping and ductwork which is to be isolated through walls and floors.
- B. Do not start up Equipment until inadequacies have been corrected in a manner acceptable to vibration isolation installer.

3.6 NOISE AND VIBRATION:

- A. Particular care shall be exercised in the selection and installation of all Mechanical Equipment and components to attain reasonable noise levels in occupied spaces. In general, sound levels for various spaces shall be maintained in accordance with the recommendations of the ASHRAE Guide. Normally the classification of noise shall be by mutual agreement but should a dispute arise regarding sound levels after occupancy of the building, representative sound measurements shall be taken to determine the average noise level in the offending space.
- B. Measurements shall be made with a calibrated sound meter, using the flat response network in decibels (db), and shall be taken first with doors and windows closed and Mechanical Equipment shut down. Upon completion of the measurements, the Mechanical Equipment shall be started and similar readings shall be taken. If the recorded increase is in excess of the maximum noise increases indicated in the following tabulation, suitable correction shall be made by the Contractor at no cost to the Owner.

1. Type of Space	Noise Increase
a. Classrooms, etc.-----	3
b. Public Lobbies -----	5
c. Workrooms, Storage, and Toilet Rooms -----	7
d. Mechanical Equipment Rooms -----	15

3.7 CURB MOUNTED UNITS

- A. All curb mounted rooftop units and energy recovery units shall be installed with a roof deck, 2" rigid insulation, and 4" sound batt insulation inside the entire perimeter of the curb, except at the duct openings.

END OF SECTION 230549

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SECTION 230554 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION OF WORK:

- A. Extent of mechanical identification work required by this Section is indicated on drawings and/or specified in other sections.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.4 SUBMITTALS:

- A. Product Data: Submit product specifications and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification materials or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

PART 2 - PRODUCTS

2.1 MECHANICAL IDENTIFICATION MATERIALS:

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

B. Plastic Pipe Markers:

1. General: Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color coded, plastic-sheet pipe markers, complying with ANSI A13.1.
 - a. Small Pipes: For external diameters 2" and smaller (including insulation if any), provide full-bank pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
 - c. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastics.

C. STENCILS

1. Provide with clean cut symbols and letters of following sizes:
 - a. 2-1/2" to 6" outside diameter of pipe or insulation: 12" long color field, 1-1/4" high letters.
 - b. 8" to 10" outside diameter of pipe or insulation: 24" long color field, 2-1/2" high letters.
 - c. 2-1/2" to 6" outside diameter of pipe or insulation: 32" long color field, 3-1/2" high letters.
 - d. Ductwork: 2-12" high letters

D. Valve Tags:

1. Engraved plastic tags: Provide laminated three-layer with engraved black letters on light contrasting background color. Piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
2. Provide 1-1/2" diameter tags, except as otherwise indicated.

E. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

F. Valve Schedule Frames:

1. General: For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

G. Engraved Plastic-Laminate Signs:

1. General: Provide engraving stock melomine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and working indicate, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
 - a. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substance.

H. Manufacturer:

1. General: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 - a. Brady (W.H.) Company, Signmark Div.
 - b. Seton Name Plate Corp.

2.2 LETTERING AND GRAPHICS:

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or schedule. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
 1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Boiler No. 3, Air Supply No. 1H, Standpipe F12).

2.3 APPLICATION AND INSTALLATION:

A. General Installation Requirements:

1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of coverings and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:

1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - a. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 - b. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces.
3. Near each valve and control device.
 - a. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
4. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
5. At access doors, manholes and similar access points which permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
 - a. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. Valve Identification:

1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, and HVAC terminal devices. List each tagged valve in valve schedule for each piping system.
2. Mount valve schedule frames and schedules in machine rooms where indicated or, of not otherwise indicated, where directed by Architect/Engineer.

D. Mechanical Equipment Identification: Provide marker on ceiling grid below VAV boxes, fan coils, etc. with equipment ID numbers.

1. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Pumps, boilers, closed circuit coolers and similar motor-driven units.
 - c. Heat exchangers, coils evaporators, and similar equipment.
 - d. Fans.
 - e. Packaged HVAC central-station units.
 - f. Tanks and pressure vessels.

PART 3 - EXECUTION

3.1 MECHANICAL IDENTIFICATION:

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8" below finished grade, directly above buried pipe.
- F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with stencil painting. Small devices, such as in-line pumps, may be identified with tags.
- G. Identify control panels and major control components outside panels with plastic nameplates.
- H. Identify thermostats relating to terminal boxes or valves with nameplates.
- I. Identify valves in main and branch piping with tags.
- J. Identify air terminal units and radiator valves with numbered tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4" diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20' on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- M. Identify ductwork with stenciled painting. Identify with air handling unit identification number and areas served.
- N. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

O. Provide Valve Identification Chart. Post framed chart in Boiler Room.

END OF SECTION 230554

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Sound measurement of equipment operating conditions.
- E. Vibration measurement of equipment operating conditions.

1.2 REFERENCE STANDARDS

- A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.
- B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2008.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau; 2005, Seventh Edition.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

1.3 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.

4. Include at least the following in the plan:
- a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - h. Expected problems and solutions, etc.
 - i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
 - j. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - n. Method of checking building static and exhaust fan and/or relief damper capacity.
 - o. Proposed selection points for sound measurements and sound measurement methods.
 - p. Methods for making coil or other system plant capacity measurements, if specified.
 - q. Time schedule for TAB work to be done in phases (by floor, etc.).
 - r. Description of TAB work for areas to be built out later, if any.
 - s. Time schedule for deferred or seasonal TAB work, if specified.
 - t. False loading of systems to complete TAB work, if specified.
 - u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - v. Interstitial cavity differential pressure measurements and calculations, if specified.

- w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - x. Procedures for formal progress reports, including scope and frequency.
 - y. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 - 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:

1. AABC MN-1, AABC National Standards for Total System Balance.
 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 4. SMACNA HVAC Systems Testing, Adjusting, and Balancing.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Having minimum of three years documented experience.
 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- F. Pre-Qualified TAB Agencies:
1. Optimum Performance Balancing.
 2. H.T. Lyons.
 3. Air Balancing Engineers, Inc.
 4. Eastern Air Balance.
 5. Mountain Air.
 6. Butler Balancing
- G. Ownership of Contract: The Testing, Adjusting, and Balancing scope of work shall be included in the Mechanical Contract. This contractor shall be responsible for directing the TAB Agencies.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.

3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

- L. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.6 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

3.7 SCOPE

- A. Test, adjust, and balance the following:
 - 1. HVAC Pumps
 - 2. Boilers
 - 3. Air Cooled Chillers
 - 4. Air Cooled Refrigerant Condensers
 - 5. Air Coils
 - 6. Terminal Heat Transfer Units
 - 7. Rooftop Air Handling & Recovery Units
 - 8. Fans
 - 9. Air Filters
 - 10. Air Terminal Units
 - 11. Air Inlets and Outlets
 - 12. Indoor Air Handling Units

3.8 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer
 - 2. Model/Frame
 - 3. HP/BHP

4. Phase, voltage, amperage; nameplate, actual, no load
5. RPM
6. Service factor
7. Starter size, rating, heater elements
8. Sheave Make/Size/Bore

B. V-Belt Drives:

1. Identification/location
2. Required driven RPM
3. Driven sheave, diameter and RPM
4. Belt, size and quantity
5. Motor sheave diameter and RPM
6. Center to center distance, maximum, minimum, and actual

C. Pumps:

1. Identification/number
2. Manufacturer
3. Size/model
4. Impeller
5. Service
6. Design flow rate, pressure drop, BHP
7. Actual flow rate, pressure drop, BHP
8. Discharge pressure
9. Suction pressure
10. Total operating head pressure
11. Shut off, discharge and suction pressures
12. Shut off, total head pressure

D. Combustion Equipment:

1. Boiler manufacturer
2. Model number
3. Serial number
4. Firing rate
5. Gas pressure at meter outlet
6. Gas flow rate
7. Heat input
8. Percent carbon monoxide (CO)
9. Percent carbon dioxide (CO₂)
10. Percent oxygen (O₂)
11. Percent excess air
12. Flue gas temperature at outlet
13. Ambient temperature
14. Net stack temperature
15. Percent combustion efficiency
16. Heat output

E. Air Cooled Condensers:

1. Identification/number
2. Location
3. Manufacturer
4. Model number
5. Serial number
6. Entering DB air temperature, design and actual
7. Leaving DB air temperature, design and actual
8. Number of compressors

F. Chillers:

1. Identification/number
2. Manufacturer
3. Capacity
4. Model number
5. Serial number
6. Evaporator entering water temperature, design and actual
7. Evaporator leaving water temperature, design and actual
8. Evaporator pressure drop, design and actual
9. Evaporator water flow rate, design and actual

G. Cooling Coils:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Entering air DB temperature, design and actual
7. Entering air WB temperature, design and actual
8. Leaving air DB temperature, design and actual
9. Leaving air WB temperature, design and actual
10. Water flow, design and actual
11. Water pressure drop, design and actual
12. Entering water temperature, design and actual
13. Leaving water temperature, design and actual
14. Saturated suction temperature, design and actual
15. Air pressure drop, design and actual

H. Heating Coils:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual

6. Water flow, design and actual
7. Water pressure drop, design and actual
8. Entering water temperature, design and actual
9. Leaving water temperature, design and actual
10. Entering air temperature, design and actual
11. Leaving air temperature, design and actual
12. Air pressure drop, design and actual

I. Air Moving Equipment:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and actual
7. Return air flow, specified and actual
8. Outside air flow, specified and actual
9. Total static pressure (total external), specified and actual
10. Inlet pressure
11. Discharge pressure
12. Sheave Make/Size/Bore
13. Number of Belts/Make/Size
14. Fan RPM

J. Return Air/Outside Air:

1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature
9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature
12. Design outside/return air ratio
13. Actual outside/return air ratio

K. Exhaust Fans:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Air flow, specified and actual

6. Total static pressure (total external), specified and actual
7. Inlet pressure
8. Discharge pressure
9. Sheave Make/Size/Bore
10. Number of Belts/Make/Size
11. Fan RPM

L. Duct Traverses:

1. System zone/branch
2. Duct size
3. Area
4. Design velocity
5. Design air flow
6. Test velocity
7. Test air flow
8. Duct static pressure
9. Air temperature
10. Air correction factor

M. Duct Leak Tests:

1. Description of ductwork under test
2. Duct design operating pressure
3. Duct design test static pressure
4. Duct capacity, air flow
5. Maximum allowable leakage duct capacity times leak factor
6. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Calibrated
7. Test static pressure
8. Test orifice differential pressure
9. Leakage

N. Terminal Unit Data:

1. Manufacturer
2. Type, constant, variable, single, dual duct
3. Identification/number
4. Location
5. Model number
6. Size
7. Minimum static pressure
8. Minimum design air flow
9. Maximum design air flow
10. Maximum actual air flow

11. Inlet static pressure

O. Air Distribution Tests:

1. Air terminal number
2. Room number/location
3. Terminal type
4. Terminal size
5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow

P. Sound Level Reports:

1. Location
2. Octave bands - equipment off
3. Octave bands - equipment on

Q. Vibration Tests:

1. Location of points:
 - a. Fan bearing, drive end
 - b. Fan bearing, opposite end
 - c. Motor bearing, center (if applicable)
 - d. Motor bearing, drive end
 - e. Motor bearing, opposite end
 - f. Casing (bottom or top)
 - g. Casing (side)
 - h. Duct after flexible connection (discharge)
 - i. Duct after flexible connection (suction)
2. Test readings:
 - a. Horizontal, velocity and displacement
 - b. Vertical, velocity and displacement
 - c. Axial, velocity and displacement
3. Normally acceptable readings, velocity and acceleration
4. Unusual conditions at time of test
5. Vibration source (if non-complying)

END OF SECTION 230593

SECTION 230714 - HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Flexible Blanket Fireproofing.
- C. Noise Barrier Wrap.

1.2 RELATED SECTIONS

- A. Section 23 0554 - Identification for HVAC Piping and Equipment.

1.3 REFERENCES

- A. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2002.
- B. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2004.
- C. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2005.
- D. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.
- E. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- G. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.
- I. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.
- C. Submit MSS information for all products.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.
- C. All insulation and adhesives shall be formaldehyde free.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. MANUFACTURER:

1. Johns Manville Corporation: www.jm.com. Microlite XG.
 - a. Approved formaldehyde-free equal.

B. Insulation: ASTM C 553-92; formaldehyde-free, flexible glass fiber, noncombustible blanket.

1. 'K' ('Ksi') value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C 518.
 - a. Maximum Service Temperature: 450 degrees F (232 degrees C).
 - b. Maximum Water Vapor Sorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:

1. Porous interior sealant primers shall not have VOC content in excess of 775 grams/liter, less water and compounds exempt by the applicable LEED standard.
2. Kraft paper with glass fiber yarn and bonded to aluminized film.
3. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
4. Secure with pressure sensitive tape.
5. Vapor Barrier Tape:
 - a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive formaldehyde-free rubber based adhesive.

2.3 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Fiber Glass: www.knauffiberglass.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 612; rigid, noncombustible blanket.

1. 'K' ('Ksi') value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C 518.
2. Maximum service temperature: 450 degrees F (232 degrees C).
3. Maximum Water Vapor Sorption: 5.0 percent.
4. Maximum Density: 8.0 lb/cu ft (128 kg/cu m).

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
3. Secure with pressure sensitive tape.

2.4 FLEXIBLE BLANKET FIREPROOFING:

A. Manufacturers:

1. 3M
2. Approved Equal.
3. Material: high temperature soluble fiber blanket encapsulated in scrim reinforce aluminum foil covering.
4. Weight: 0.75 lb/sf
5. Systems: Ducts requiring 2 hour fire rating.
6. Combustibility (ASTM E-136): Noncombustible.
7. Two layers required.
8. Must conform with governing IMC requirements.

2.5 NOISE BARRIER WRAP (HUSH CLOTH)

A. Manufacturers:

1. Kinetics Noise Barrier Type KNM-100ALQ.
2. BRD
3. Approved Equal
4. Provide barium sulphate loaded limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side.

B. Provide nominal density of 1 PSF and minimum STC rating of 28.

C. Barrier shall have minimum thermal conductivity "K" value of 0.29 and rated temperature range of -40 degrees C to 105 degrees C.

D. Provide decoupling layer of 2" fiberglass batting, non-woven porous scrim coated glass cloth, quilted together in a matrix of 100 mm (4") diamond stitch pattern encapsulating the glass fibers. Decoupler shall be model KFA by Kinetics or equal.

E. The composite material shall be fabricated to include a nominal 6" wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak tight seal around all field joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated ducts conveying air below ambient temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
 - 5. Insulated ducts conveying air above ambient temperature:
 - a. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. External Duct Insulation Application:
 - 1. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 2. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 3. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 - 4. Install Insulation materials with smooth and even surfaces.
 - 5. Maintain integrity of vapor barrier on ductwork insulation, and protect it to prevent puncture and other damage.
 - 6. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations except where otherwise indicated.

3.3 PROTECTION AND REPLACEMENT:

- A. Replace damaged insulation, which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

- B. Protection: The installer of the ductwork insulation shall advise the contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.4 SCHEDULES **(Addendum 04)**

- A. All fresh air intake ducts from the outside intake louver or vent to the unit casing shall be insulated on the outside with 2" thick fiberglass.
- B. All supply air ductwork of air conditioning systems shall be externally insulated except where ductwork is installed exposed in the conditioned space.
- C. Return air ductwork of air conditioning systems shall be insulated wherever the ductwork runs under a roof. Insulation thickness shall be 1.5"
- D. All exhaust and relief air ducts shall be externally insulated with 2.0" thick fiberglass from the backdraft device to the louver.
- E. Dual Temperature Ductwork:
1. Application Requirements: Where leaving air temperature is alternately above and below ambient temperature insulate and vapor seal ductwork.
 2. Externally Insulated Ductwork: Provide with one of the following types and thicknesses of insulation, except as otherwise indicated:
 - a. Insulation: Rigid mineral fiber, 3 PCF in concealed areas, 6 PCF in exposed areas, supply and return ducts – 2.0" thick, outside air ducts – 2" thick.
 - b. Insulation: Flexible mineral fiber, 2" thick, application limited to concealed locations. Density shall be 1.5 pounds/cubic foot.
- F. Noise Barrier Duct Wrap
1. Provide Noise Barrier Wrap (Hush Cloth) where indicated on the drawings.
- G. Kitchen Hood Grease Exhaust:
1. **Provide UL approved external fire-retardant insulation for all grease exhaust ductwork. External wrap shall provide minimum of 2-hour fire resistance rating and be compliant with all IMC requirements.**
- H. Exterior Ductwork:
1. **Exterior ductwork within curbs shall be treated with either product accepted under Dual Temperature Ductwork outside of building envelope. Insulation shall be in addition to any internal lining.**

END OF SECTION 230714

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment insulation.
- B. Covering.

1.2 RELATED SECTIONS

- A. Section 23 0554 - Identification for HVAC Piping and Equipment.
- B. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 23 21 14 - Hydronic Specialties.
- D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCES

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
- C. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2010.
- D. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007.
- E. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007.
- F. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- G. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2011.
- H. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2012.

- I. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2011.
- J. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2010.
- K. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.
- L. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2010.
- M. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- O. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturers:

- 1. Knauf Insulation: www.knaufusa.com.
- 2. Johns Manville Corporation: www.jm.com.
- 3. Owens Corning Corp: www.owenscorning.com.
- 4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 553; flexible, noncombustible.

- 1. 'K' Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
- 2. Maximum Service Temperature: 450 degrees F.
- 3. Maximum Water Vapor Sorption: 5.0 percent by weight.

C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.

- 1. Moisture Vapor Permeability: 0.029 ng/Pa s m (0.02 perm inch), when tested in accordance with ASTM E 96/E 96M.
- 2. Secure with self-sealing longitudinal laps and butt strips.

2.3 GLASS FIBER, RIGID

A. Manufacturer:

- 1. Knauf Insulation: www.knaufusa.com.
- 2. Johns Manville Corporation: www.jm.com.
- 3. Owens Corning Corp: www.owenscorning.com.
- 4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 612 or ASTM C592; rigid, noncombustible.

1. 'K' Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
2. Maximum Service Temperature: 850 degrees F.
3. Maximum Water Vapor Sorption: 5.0 percent by weight.
4. Maximum Density: 8.0 lb/cu ft.

C. Vapor Barrier Jacket:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.029 ng/Pa s m (0.02 perm inch), when tested in accordance with ASTM E 96/E 96M.
3. Secure with self-sealing longitudinal laps and butt strips.

2.4 JACKETS

A. PVC Plastic:

1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com.
2. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: -40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.029 ng/Pa s m (0.02 perm inch), when tested in accordance with ASTM E 96/E 96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.

1. Thickness: 0.016 inch sheet.
2. Finish: corrugated.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION (Addendum 04)

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated equipment containing fluids below ambient temperature: Insulate entire system.
- G. Fiber glass insulated equipment containing fluids below ambient temperature: Provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- K. Inserts and Shields:
 - 1. Application: Equipment 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between hangers and inserts.
 - 3. Insert location: Between support shield and equipment and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Equipment in Mechanical **Equipment** Rooms or Finished Spaces: Finish with ~~canvas jacket~~ **sized PVC or aluminum jacket ready** for finish painting.
- N. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

- O. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.
- P. Replace damaged insulation which cannot be repaired satisfactorily including units with vapor barrier damage and moisture saturated units.
- Q. Protection: Insulation Installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.3 SCHEDULE (Addendum 04)

- A. Heating Systems:
 - 1. Pump Bodies: 2" thick rigid fiberglass with cement finish
 - 1) Provide removable sheet metal insulation boxes with cam locks for pumps.
 - 2. Air Separators: 2" thick flexible unicellular.
 - 3. Expansion Tanks: 2" thick flexible unicellular.
- B. Chilled Water Systems:
 - 1. Pump Bodies: 1.5" thick flexible unicellular.
 - 1) Provide removable sheet metal insulation boxes with cam locks for pumps.
 - 2. Air Separators: 1.5" thick flexible unicellular.
 - 3. Expansion Tanks: 1.5" thick flexible unicellular.
- C. Dual Temperature Systems:
 - 1. **VAV Box Re-heat Coil: 1.5" thick fiberglass (except where unit is installed exposed in a conditioned space)**

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.2 RELATED SECTIONS

- A. Section 07 8413 – Penetration Firestopping.
- B. Section 07 8443 – Joint Firestopping.
- C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
- D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCES

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
- C. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2010.
- D. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007.
- E. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2000.
- F. ASTM C 533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2011.
- G. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2007a.
- H. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation; 2012.
- I. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2012.

- J. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2011be1.
- K. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 2010.
- L. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2012a.
- M. ASTM C 610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation; 2011.
- N. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008.
- O. ASTM D 1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2007.
- P. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2006.
- Q. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.
- R. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2010.
- S. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- T. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- U. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.2 GLASS FIBER

- A. Manufacturers:

1. Knauf Insulation: www.knaufusa.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.

- B. Insulation: ASTM C 547 and ASTM C795; rigid molded, noncombustible.

1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum service temperature: 850 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.

- C. Insulation: ASTM C 547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.

1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum service temperature: 650 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.

- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

- 1. Armacell LLC

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3; use molded tubular material wherever possible.

- 1. Minimum Service Temperature: -40 degrees F.
- 2. Maximum Service Temperature: 220 degrees F.
- 3. Connection: Waterproof vapor barrier adhesive.

2.4 JACKETS

A. PVC Plastic.

1. Manufacturers:

- a. Johns Manville Corporation: www.jm.com.
- b. Owens Corning Corp..
- c. Knauf Insulation.

2. Jacket: One piece molded type fitting covers and sheet material, off-white color.

- a. Minimum Service Temperature: 0 degrees F.
- b. Maximum Service Temperature: 150 degrees F.
- c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
- d. Thickness: 10 mil.
- e. Connections: Brush on welding adhesive.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.

- 1. Thickness: 0.016 inch sheet.
- 2. Finish: Smooth.
- 3. Joining: Longitudinal slip joints and 2 inch laps.
- 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
- 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations. Exposed piping in visible areas shall be wrapped in an aluminum jacket with a paint-grip finish.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- E. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- F. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- H. Exterior Applications: Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

- I. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum or PVC jacket as noted in the schedule with seams located on bottom side of horizontal piping. Provide warning tape on exterior of pipe indicating that the piping is heat traced.
- J. General: Install insulation products in accordance with the manufacturer's written instructions, and in accordance with the recognized industry practices to ensure that the installation serves its intended purpose.
- K. Install insulation of pipe systems subsequent to testing and acceptance of tests.
- L. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete the run. Do not cut pieces of scraps abutting each other.
- M. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- N. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at installer's option) except where a specific form or type is indicated. Valves in chilled water systems shall be insulated with removable factory pre-molded insulators. Any condensation problems shall be corrected by the Contractor. Damage to finishes caused by condensation shall be corrected by this Contractor.
- O. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- P. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.
- Q. Pipe Hanger Insulation Inserts: Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 inch wide vapor barrier stage or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inch wide vapor barrier tape or band.
- R. Replace damaged insulation which cannot be repaired satisfactorily including units with vapor barrier damage and moisture saturated units.
- S. Protection: Insulation Installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.3 SCHEDULE

A. HVAC Systems:

1. HVAC PIPING SYSTEM INSULATION:

- a. Sub-Freezing Piping (0 to 39 Deg. F.) (-18 to 4 Deg. C.):
 - 1) Application Requirements: Insulate the following sub-freezing HVAC piping systems:
 - (a) Refrigerant suction and liquid lines between evaporators and condensing units.
 - 2) Insulate each piping system specified above with one of the following types and thickness of insulation:
 - (a) Insulation: Flexible unicellular 1.5" thick. Cover outdoor insulation with aluminum jacket.
- b. Cold Piping (40 Deg. F. (4.4 Deg. C. to ambient):
 - 1) Application Requirements: Insulate the following cold HVAC piping systems:
 - (a) Copper air conditioning condensate piping. (Insulation not required on PVC condensate piping).
 - (b) Chilled water piping systems.
 - 2) Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - (a) Insulation: Flexible Unicellular; 1.5" thick on chilled water. 1/2" thick on condensate drains.
 - (b) Outdoor Application: Increase insulation thickness by 1 inch. Where pipes are heat traced, increase size to accommodate the heat tracing. Cover with 22 gauge corrugated aluminum with all joints sealed watertight.
- c. Hot Low Pressure Piping (to 250 Deg. F. (121 Deg. C.):
 - 1) Application Requirements: Insulate the following hot low pressure HVAC piping systems.
 - (a) HVAC hot water supply and return piping.
 - 2) Insulate each piping system specified above with one of the following types and thickness of insulation:
 - (a) Insulation: Fiberglass; 1 1/2" thick for pipe sizes up to and including 1.5". 2" thick for pipe sizes 2" and larger.
 - (b) Insulation: Flexible unicellular 1.5" thick for pipe sizes up to and including 1.5".
 - 3) Cover outdoor insulation with 22 gauge corrugated aluminum.
- d. Outdoor Pipes:
 - 1) Outdoor HVAC water pipes, including piping located in air handling unit pipe portals, shall be heat traced and insulated with 2 inch insulation, and covered with an aluminum jacket. Refer to paragraphs 3.2.H and I.

END OF SECTION 230719

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SECTION 230923 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements, (if any), apply to the work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. The extent of the electric/electronic Direct Digital Control temperature control work is indicated by drawings and schedules and by the requirements of this section.
- B. Control sequence is hereby defined to mean the manner in which, and methods by which, the automatic temperature controls function. The requirements for each type of operation are specified in this section.
- C. The control system shall be Schneider Electric EcoStruxure by the Tri-M Group. Contact Matt Prisuta (MPrisuta@tri-mgroup.com) (484)790-5760. Substitutions will not be permitted.

1.3 GENERAL:

- A. The temperature control manufacturer shall furnish all material, equipment and services necessary for the proper installation of an electric/electronic system of automatic temperature controls. Temperature control equipment shall submit to the Engineer for approval shop drawings of the entire control system prior to commencement of work.
- B. After completion of the installation, the automatic temperature control contractor shall adjust all thermostats, control dampers, motors and other equipment provided under his contract with trained personnel in the direct employ of the temperature control manufacturer. The control system as shown on the Drawings and specified herein shall be guaranteed free from defects in workmanship and materials under normal use and service for a period of one year, after acceptance by the Engineer and/or Owner.
- C. Any equipment herein described proved to be defective in workmanship or material during the guarantee period shall be adjusted, repaired or replaced by the automatic temperature control manufacturer at no charge to the Owner. Instructions shall be given to Owner's personnel.

1.4 SCOPE OF WORK: **(Addendum 01)**

- A. The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems as herein specified. Complete temperature control system as specified herein. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.
- B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- C. BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.
- ~~D. BAS manufacturer shall provide a lifetime license for the software for this facility. License shall include future software upgrades. Software licenses shall be managed through District's Contract with the sub-contractor for service.~~**
- E. BAS manufacturer shall be responsible for installation of their system on District-provided servers and on two District-owned laptop computers.

1.5 COORDINATION OF WORK:

- A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc. furnished by BAS manufacturer.
- B. Electrical Contractor provides:
 - 1. 120 volt power wiring and data where shown on the drawings. Any and all other 120V power as required for all controls operations and devices shall be provided by the BAS manufacturer as part of the heating contract.
 - 2. Wiring of all power feeds through all disconnect starters to electrical motor.
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer.
- C. Products furnished but not installed under this section:
 - 1. Section 23 2113 Hydronic Piping:
 - a. Control Valves

- b. Flow Switches
- c. Temperature Sensor Wells and Sockets
- d. Flow Meters
- 2. Section 23 3100 - Duct-work Accessories:
 - a. Automatic Dampers
 - b. Air-flow Stations
 - c. Terminal Unit Controls

1.6 QUALITY ASSURANCE

- A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 75 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.
- B. The manufacturer shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS.
- C. The Bidder shall be regularly engaged in the manufacturing, installation, and maintenance of the specified BAS systems, and shall have a minimum of ten (15) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project. The Bidder must also have and maintain a service organization consisting of at least ten (10) competent servicemen for a period of not less than ten years and the provide a list of 10 projects, similar in size and scope to this project completed within the last five years.
- D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- E. BAS shall comply with UL 916 PAZX and 864 UDTZ, ULC, and other subsystem listings as applicable, and herein specified, and be so listed at the time of bid.
- F. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- G. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

- H. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.7 CODE COMPLIANCE

- A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
- B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electrical Code.
- D. All smoke dampers shall be rated in accordance with UL 555S.
- E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
- F. Comply with FCC, Part 68 rules for telephone modems and data sets.
- G. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- H. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.
- I. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.8 SUBMITTALS

- A. Provide submittals for fast track items that need to be approved and released to meet the schedule of the project. Provide submittals for the following items separately upon request:
 - 1. Valve schedule and product data
 - 2. Damper schedule and product data
 - 3. Mounting and wiring diagrams for factory-installed control components
- B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:
 - 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.
 - 3. Details of control panel faces, including sizes, controls, instruments, and labeling.
 - 4. Schedule of dampers and actuators including size, leakage, and flow characteristics. If dampers are furnished by other, submit a schedule coordinating actuator sizes with the damper schedule.
 - 5. Schedule of valves including leakage and flow characteristics.
 - 6. Written description of the Sequence of Operations.
 - 7. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
 - 8. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 9. Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.
- C. Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
- D. Variance letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.

1.9 WARRANTY

- A. Conform to the warranty requirement of the Contract Documents, General Requirements and this section or a minimum of 12 months. This warranty shall apply equally to both hardware and software.
- B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system demonstration.
- C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.
- D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.

1.10 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.
- C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D. Coordinate 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".
- E. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

1.11 SYSTEM DESCRIPTION

- A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.
- B. For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): The BAS Contractor shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
 2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
 3. Ethernet-based Network Router and/or Network Server Controller(s) (NSCs): The BAS Contractor shall furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units (SDCUs) and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
 4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).
- C. The Local Area Network (LAN) shall be either a 10 or 100 Mbps Ethernet network supporting BACnet, Modbus, XML and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.
- D. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

- E. The system shall enable an open architecture that utilizes ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.
- F. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 Kbaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.
- G. The software tools required for network management of the BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP.
- H. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.
- I. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.
 - 1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
 - 2. Data shall reside on a supplier-installed server for all database access.
 - 3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
- J. Provide the Commissioning, configuration and diagnostic software, and interfaces to provide uploading/downloading and monitoring of all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of time schedules.

PART 2 - PRODUCTS

2.1 SYSTEM ARCHITECTURE

A. General

1. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire project, and interface with the Local Area Network (LAN) or Wide Area Network (WAN) as required.
2. The Building Automation System (BAS) shall consist of:
 - a. Network Server/Controllers (NSCs),
 - b. Standalone Digital Control Units (SDCUs)
 - c. Administration and Programming Workstations (APWs)
 - d. Enterprise Server (ES) (optional, used on large jobs)
 - e. Report Server (RS) (optional, used on jobs for extended logging/reporting capabilities)
 - f. Web-based Operator Workstations (WOWs)..
3. Where two or more NSCs are included, an Enterprise Server is required, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from Workstations simultaneously for operations and engineering tasks.
4. The Enterprise Level BAS shall be able to host up to 250 Network Servers (NSCs) beneath it.
5. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows SQL based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
6. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, and/or Modbus TCP protocol.

B. Modbus RTU, Modbus TCP, BACnet MS/TP, BACnet IP, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow these protocols to be natively supported.

C. A Fieldbus network of Standalone Digital Control Units (SDCUs) using the BACnet IP, BACnet MS/TP protocol shall connect the SDCUs with an Ethernet-level NSC using managed Ethernet switches where required. The NSC shall have a fixed IP address for connection the facility network and the SDCUs shall have separate, non-facility BACnet addresses assigned and managed by the NSC.

- D. BACnet IP Fieldbus SDCUs shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 39 if using RSTP, per layer, with a max of 5 sub networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs.
- E. BACnet MS/TP Fieldbus SDCUs shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.
- F. BAS LAN Segmentation: The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.
- G. Standard Network Support: All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.
- H. Web Services : The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable. The NSC shall be able to "consume" data into the system via SOAP and REST web services
- I. System Expansion
 - 1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
 - 2. Web-based operation shall be supported directly by the NSCs and require no additional software.
 - 3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
 - 4. All Network Server Controllers must natively support the open systems protocols of: BACnet IP, BACnet MS/TP, Modbus TCP and Modbus RTU protocols.

2.2 OPERATOR WORKSTATION REQUIREMENTS

A. General

1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 2 concurrent operator users and/or 1 concurrent engineering user.
2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
3. Web-based workstations (webstations) shall have a minimum of 5 concurrent operator users.
4. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
5. A minimum of 2 physical Workstations shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC.

B. Workstation, Programming Workstation, and Enterprise Server Requirements (specifier to depict owner provided server or controls contractor provided server):

1. Processor Intel Core i5 @ 3.0 GHz or better
2. Memory: Minimum: 8GB RAM, 300 GB or larger hard disk, DVD drive
3. Operating systems:
 - a. Microsoft Windows 10 64-bit (Pro or Enterprise)
 - b. Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
 - c. Microsoft Windows Server 2012 or 2102 R2 or 2016 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
4. 10/100MBPS Ethernet NIC
5. SQL (Report Server only) Software - Microsoft SQL Server 2008 R2 with SP2 or 2012 64-bit (Standard and Express with Advanced Services)
6. License agreement for all applicable software

C. Web-Based Operator PC Requirements - Any user on the network can access the system, using Internet Explorer 11, or Mozilla Firefox, or Google Chrome

D. System Software Architecture

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. Programming of controllers shall be capable of being done either off-line or on-line from any programming workstation. All information will be available in graphic displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable
4. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.
 - a. Additional requirements include mandatory change of passwords:
 - 1) At first logon with default credentials
 - 2) Of admin passwords before deploying
 - b. No general accounts, one account per user
 - c. Capability to integrate and use Windows Active Directory for user log on credentials
 - d. Include a timed auto log off feature
 - e. Use TLS 1.2 encryption or higher
 - f. Capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
 - g. All devices and software that support HTTP shall allow disabling the HTTP access and require access via HTTPS.
 - h. All devices that have web portals for the configuration of IP addresses and other configuration attributes shall have the ability, through commands issued, to disable this service upon completion. A direct connection method with ASCII commands shall enable this service again if changes need to be applied. Loss of power or cycling the device shall not reverse

this command. Disabling this web portal eliminates the security risk and the need for updating security patches.

- i. All devices shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
- j. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
- k. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.

E. Web-based Operator Software

- 1. General:
 - a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
 - b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
- 2. Graphic Displays
 - a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
 - b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
- 3. Alarm Management
 - a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
 - b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.
- 4. Groups and Schedules
 - a. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

- b. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.
 - 5. User Accounts and Audit Trail
 - a. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
 - b. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.
- F. User Workstation:
- 1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
 - 2. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
 - 3. Personalized layouts and panels based on username and passwords within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
 - 4. Workstations, Servers and NSCs shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
 - 5. Workstation shall indicate at all times the communication status between it and the server.
- G. Administration and Programming Workstation
- 1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created from the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays

1. The Administration and Programming Workstation shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
 - a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
 - b. The system shall support HTML5 enabled graphics.
 - c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
 - d. The editor shall use Scalable Vector Graphics (SVG) technology.
 - e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
 - f. Support for high definition icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
 - g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
 - h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.

- i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
 - j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
 - k. Graphics should rescale based on whatever monitor or viewing device is being used.
 - l. Be able to create graphics on varying layers that can be moved and repeated.
 - m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
 - n. The ability to create re-usable cascading menus.
 - o. The ability to have multiple instances of a graphic and edit one instance to change all.
3. Additionally, the Graphics Editor portion of the Engineering Workstation Software shall provide the following capabilities:
- a. Create, Modify and save pages.
 - b. Modify an existing symbol and Group and Ungroup symbols.
 - c. Place a symbol on a page and Rotate and Mirror a symbol.
 - d. Place analog dynamic data and changeable setpoints on a page.
 - e. Place binary dynamic data using custom state descriptors on a page.
 - f. Create motion through the use of animated .gif files or JavaScript.
 - g. Place links to other pages, websites, notes, time schedules and various files like .pdf, .doc, .exe etc. on the Workstation using a fixed symbol or flyover on a page.
 - h. Place alarm indicators on a page.
 - i. Change symbol/text/value color as a function of an analog or binary variable.
 - j. All symbols used in the creation of graphic pages shall be saved to a library file for use by the owner.
- I. Automatic monitoring
- 1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management

1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
 - a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels. At the Enterprise level the minimum number of active and viewable alarms shall be 10,000. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
 - b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
 - c. Playing an audible sound on alarm initiation or return to normal.
 - d. Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software using Simple Mail Transfer Protocol (SMTP) with support for secure email using Simple Mail Transfer Protocol Secure (SMTPS) No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
 - e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-4pm, Mon-Fri) and to a Central Alarming workstation at all other times.
 - f. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
 - g. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
 - h. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

- i. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
- j. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to 'normal' and the quantity of disabled and hidden alarms.
- k. The alarm viewer can be configured to auto hide alarms when triggered.
- l. An operator shall have the capability to assign an alarm to another user of the system.
- m. Time schedules shall be able to be used to set control notifications to users.
- n. An operator shall have the capability to save and apply alarm favorites.
- o. Alarm notifications must support multiple distribution methods within one notification.

K. Report Generation (optional)

- 1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
- 2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
- 3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.
- 4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
- 5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
- 6. All reports shall be able to be set up to automatically run or be generated on demand.
- 7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
- 8. Reports can be of any length and contain any point attributes from any controller on the network.
- 9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
- 10. It shall be possible to run other executable programs whenever a report is initiated.
- 11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
- 12. Minimum supplied reports shall include:
 - a. Activities Per Server Report
 - b. Activities Per User Report
 - c. Alarm Amount by Category Report
 - d. Alarm Amount by Type Report

- e. Alarms Per Sever Report
 - f. Current Alarm Report
 - g. Most Active Alarm Report
 - h. System Errors Per Server Report
 - i. Top Activities Report
 - j. Top Alarms Report
 - k. Top System Errors Report
 - l. Trend Log Comparison Report
 - m. User Logins Report
 - n. Users and Groups Reports
13. Minimum Energy Reports shall include:
- a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
 - b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
 - c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

L. Scheduling

- 1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
- 2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
- 3. Schedules shall be programmable for a minimum of one year in advance.
- 4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
- 5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
- 6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
- 7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
- 8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
- 9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
- 10. It should accommodate a minimum of 16 priority levels.

11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer's Environment

1. Programming shall allow both graphical block format and line-programming format. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs. Both languages will have debugging capabilities in their editors.
2. Programming of the NSC and SDCUs shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
4. It shall be possible to view graphical programming live and real-time from the Workstation.
5. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
6. Key terms should automatically complete when typing (IntelliType).
7. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different functions.
8. The system shall be able to create macro objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.
9. The workstation software shall have an application to save and restore programming and graphic files. The application must also be able to save/reload individual programs in the controller allowing modification of control programs without disturbing any other online functions.

N. Audit Trail

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. The Enterprise server shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.

5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. It shall be capable to search and view all forced values within the system.

2.3 NETWORK SERVER CONTROLLERS (NSCS)

- A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.
- B. The NSC shall be classified as a “native” BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
- C. The NSC shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.
- D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.
- E. Whitelisting of file extensions for documents shall be capable.
- F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2
- G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.
- H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.
- I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU, chiller system or boiler system.
- J. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.
- K. Each NSC shall be capable of executing application control programs to provide:

1. Calendar functions

2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization by means of an Internet site including automatic synchronization
6. Native integration of Modbus controller data or BACnet controller data

L. Hardware Specifications

1. Memory:
 - a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Each NSC shall provide the following on-board hardware for communication:
 - a. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
 - 1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
 - 2) Support IPv4 addressing
 - 3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
 - 4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
 - 5) It shall be possible to disable Ethernet port 2
 - 6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
 - 7) Each NSC shall be able to support a total of 250 IP SDCUs in daisy chain configuration (5 sub networks via switch)
 - 8) If using RSTP (Rapid Spanning Tree Protocol) with a managed switch (with IEEE 802.1W or IEEE 802.1Q-2014 support), Ethernet port 2 shall support up to 39 devices
 - 9) Each NSC shall be able to support a total of 234 IP SDCUs in RSTP configuration (6 sub networks via managed switch)
 - 10) Where a switch is needed, use Planet IGS-801M, or other equal and approved equivalent.
 - a) Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
 - b) One device USB port
 - c) One host USB port

M. Modular Expandability:

1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic.
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

N. Hardware Override Switches:

1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

O. Universal Input Temperatures

1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
 - a. 10 kohm Type I, II, III, IV or V
 - b. 1.8 kohm (Xenta), 1 kOhm (Balco), 20 kOhm (Honeywell) and 2.2 kOhm (JCI)

P. Local Status Indicator Lamps:

1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

Q. Real Time Clock (RTC):

1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
2. The RTC date and time shall also be accurate, up to 30 days, when the NSC is powerless.
3. No batteries may be used to for the backup of the RTC.

R. Power Supply:

1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and any associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

S. Automatic Restart After Power Failure:

1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.
2. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

T. Software Specifications

1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

U. User Programming Language:

1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a “canned” program method will not be accepted.

V. Control Software:

1. The NSC shall have the ability to perform the following pre-tested control algorithms:
 - a. Proportional, Integral plus Derivative Control (PID)
 - b. Two Position Control
 - c. Digital Filter
 - d. Ratio Calculator
 - e. Equipment Cycling Protection

W. Mathematical Functions:

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

X. NSCs shall have the ability to perform any or all of the following energy management routines:

1. Time of Day and Calendar Scheduling with Holiday and Temporary Overrides
2. Optimal Start & Optimal Stop with Night Setback Control
3. Enthalpy Switchover (Economizer)
4. Peak Demand Limiting
5. Temperature Compensated Duty Cycling
6. Supply Fan demand based pressure reset
7. Heating/Cooling Interlock with Hot/Cold Deck Reset

8. Hot Water, Chilled Water and Condenser Reset
9. Chiller Sequencing and Chiller Plant Optimization

Y. History Logging:

1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.

Z. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.

5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

AA. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

2.4 BACNET IP FIELDBUS CONTROLLERS (SDCUS)

A. Controllers – BACnet/IP Protocol

1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
 - a. All controllers shall be able to communicate peer-to-peer without the need for a NSC
 - b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

- B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

1. Supporting IPv4 addressing
2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
3. It shall be possible to disable Ethernet port 2

C. Topologies

1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
 - a. In case of any disruption there shall be no communication interruption
 - b. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability

1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs

7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
 - a. Control processes
 - b. Energy management applications
 - c. Alarm management
 - d. Historical/trend data
 - e. Maintenance support applications
 - f. Custom processes
 - g. Manual override monitoring
9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
 - a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
 - 1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
 - a) 10 kohm Type I, II, III, IV or V
 - b) 1.8 kohm (Xenta), 1 kOhm (Balco), 20 kOhm (Honeywell) and 2.2 kOhm (JCI)
 - 2) Analog inputs
 - a) Current Input - 0-20 mA
 - b) Voltage Input 0-10 Vdc
 - 3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - 4) Digital outputs
 - 5) Analog outputs of 4-20 mA and/or 0-10 Vdc
13. Real Time Clock (RTC):
 - a. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month. The RTC shall provide the following: time of day, day, month, year, and day of week.
 - b. The RTC date and time shall also be accurate, up to 7 days, when the BACnet/IP Fieldbus controller is powerless.
 - c. No batteries may be used to for the backup of the RTC.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
 - a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in 'flow thru' differential pressure transducer

- b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of $\pm 5\%$ at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within $\pm 5\%$ of setpoint at the specified minimum and maximum air flow parameters
 - c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
 - d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
 - e. All balancing parameters shall be synchronized in NSC
 - 15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
 - 16. Power Requirements.: 24VDC (21 to 33 VDC) and 24 VAC $\pm 20\%$ with local transformer power
- F. Commissioning Tool - The BACnet/IP Fieldbus controller shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout
- 1. The Commissioning Tool shall be supported across: iOS, Android and Windows 10 platforms
 - 2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store
 - 3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via a Bluetooth adapter interface through the Intelligent Space Sensor or via a Wi-Fi access point on the LAN
 - 4. Functionality
 - a. Device Configuration – the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller
 - b. Programming – The Commissioning Tool shall be able to load offline engineered applications directly in to the controller directly
 - c. Air Balancing
 - 1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
 - 2) The Commissioning Tool shall be able to generate Air Balancing report
 - d. IO Checkout
 - 1) The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live
 - 2) The Commissioning Tool shall be able to support generation of I/O checkout report

- e. There shall be no limit to the number of Commissioning Tools that can be used on a network segment, however, one connection per controller is recommended
- G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on board inputs or outputs
 - 1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable
 - 2. The Intelligent Space Sensor shall provide 2 RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream
 - 3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O
 - 4. Each Intelligent Space Sensor shall provide a color touch display with a Minimum 61 mm (2.4”) by 61 mm (2.4”) display that is backlit
 - 5. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ± 0.2 °C (± 0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C. Sensing Element: 10k Type 3 Thermistor, Accuracy of ± 0.2 °C (± 0.4 °F)
 - 6. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH, Accuracy: ± 2 % RH)
- H. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
 - 1. Accuracy: ± 30 ppm $\pm 2\%$ of measured value
 - 2. Operating elevation: 0 to 16,000 ft.
 - 3. Temperature dependence: 0.11% FS per °F
 - 4. Stability: <2% of FS over life of sensor (15 years)
 - 5. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling
- I. The Intelligent Space Sensor shall have the option for motion sensor
- J. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
 - 1. Space temperature
 - 2. Cooling space temperature set point
 - 3. Heating space temperature set point

4. Current heating or cooling mode
5. Current occupancy mode
6. Fan speed
7. Current time

2.5 BACNET MSTP FIELDBUS CONTROLLERS (SDCUS)

A. Field Bus Wiring and Termination

1. The wiring of MSTP controller shall use a bus or daisy chain concept with no tees, stubs.
2. Each field bus shall have a termination resistor at both ends of each segment.

B. Field Bus Devices

1. General Requirements

- a. Devices shall have a light indicating that they are powered.
- b. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

C. Advance Application Controllers (B-AAC)

1. The key characteristics of a B-AAC are:
 - a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
 - b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
 - c. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
 - d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
 - e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
 - f. If local alarm message initiation is embedded, the B-AAC shall:

- 1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
 - 2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
- g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
- h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
- i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
- j. Shall support the “Who is” and “I am.” BACnet services.
- k. Shall support the “Who has” and “I have.” BACnet services.
2. Analog Input Circuits
 - a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
 - b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
 - c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
 - d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.
3. Binary Input Circuits
 - a. Dry contact sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
 - a. Pulse input sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
 - c. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
 - a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to

- 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
- b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
6. Binary Output Circuits
- a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
 - b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
7. Program Execution
- a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
 - b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
 - c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
 - d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
 - e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

PART 3 - AUXILIARY CONTROL DEVICES

3.1 GENERAL DEVICE REQUIREMENTS

- A. The use or installation of wireless equipment must be pre-approved by the owner and engineer. (Specifier to determine whether wireless devices are acceptable)

3.2 CONTROL VALVES

- A. Control valves shall be two-way or three-way type for two position or modulating service as shown.
- B. Close-off (Differential) Pressure Rating: Water Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - 1. Two Way: Close-off (Differential) Pressure Rating of actuator and trim shall be furnished to 150 percent of total system (pump) head.
 - 2. Three Way: Close-off (Differential) Pressure Rating of actuator and trim shall be furnished to 300 percent of pressure differential between ports A and B at design flow or 100 percent of total system (pump) head.

C. Water Valves

1. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
2. Sizing Criteria
 - a. Two Position Service: Line size with Close-off (Differential) Pressure Rating of actuator and trim of a minimum of 150 percent of total system (pump) head.
 - b. Two Way Modulating Service: Pressure drop shall be equal to 50 percent of the pressure difference between supply and return mains, or 5 PSI, whichever is greater.
 - c. Three Way Modulating Service: Pressure drop equal to twice the pressure drop through the coil, 5 PSI maximum.
 - d. Valves 1/2 inch through two inches shall be bronze body or cast brass ANSI Class 250, spring loaded, PTFE packing, quick opening for two position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - e. Valves 2-1/2 inches and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
3. Water valves shall fail (normally open or closed), as scheduled on plans, or as follows:
 - a. Water Zone Valves: Normally open preferred.
 - b. Heating Coils in Air Handlers: Normally open.
 - c. Chilled Water Control Valves: Normally closed.
 - d. Terminal Water Control Valves: Last position unless indicated otherwise.
 - e. Other Applications: As scheduled or as required by sequences of operation.

D. Approved manufacturer: Belimo, Schneider Electric

3.3 CONTROL DAMPERS

- A. Unless otherwise specified elsewhere, shall be as below or as scheduled on drawings.
1. Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct airstreams toward each other.
 2. Other modulating dampers shall be the opposed blade type.
 3. Two position shutoff dampers may be parallel or opposed blade type with blade and side seals.
- B. Damper frames shall be 13 gauge galvanized steel channel or 1/8 inch extruded aluminum with reinforced corner bracing.
- C. Damper blades shall not exceed 20 centimeters (eight inches) in width or 125 centimeters (48 inches) in length. Blades are to be suitable for medium velocity performance (2000 FPM). Blades shall be not less than 16 gauge.
- D. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze or better.

- E. All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at four inches w.g. differential pressure. Provide air foil blades suitable for a wide-open face velocity of 1500 FPM.
- F. Individual damper sections shall not be larger than 48 inches by 60 inches. Provide a minimum of one damper actuator per section.
- G. Modulating dampers shall provide a linear flow characteristic where possible.
- H. Dampers shall have exposed linkages.
- I. Approved manufacturer: Arrow or approved equal.

3.4 ELECTRIC ACTUATORS FOR CONTROL DAMPERS OR CONTROL VALVES

- A. The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.
- B. Where shown, for power failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided.
- C. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
- D. All 24 VAC/VDC actuators shall operate on Class 2 wiring.
- E. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 7 N.m (60 inches-pound) torque capacity shall have a manual crank for this purpose.
- F. Approved manufacturer: Belimo, Schneider Electric

3.5 TEMPERATURE SENSORS

- A. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
- B. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of five feet in length per ten square feet of duct cross section.
- C. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.

- D. Space sensors shall be equipped with setpoint adjustment, override switch, display, and/or communication port as shown.
- E. Provide matched temperature sensors for differential temperature measurement.
- F. Low Limit Thermostats: Low limit air stream thermostats shall be UL listed, vapor pressure type, with an element of 20 feet minimum length. Element shall respond to the lowest temperature sensed by any one foot section. The low limit thermostat shall be manual reset only.
- G. Approved manufacturer: Schneider Electric

3.6 HUMIDITY SENSORS

- A. Duct and room sensors shall have a sensing range of 20 percent to 80 percent.
- B. Duct sensors shall be provided with a sampling chamber.
- C. Outdoor air humidity sensors shall have a sensing range of 20 percent to 95 percent relative humidity. They shall be suitable for ambient conditions of -40 degrees F to 170 degrees F.
- D. Humidity sensor's drift shall not exceed one percent of full scale per year.
- E. Approved manufacturer: Schneider Electric, Veris

3.7 RELAYS

- A. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

3.8 LOCAL CONTROL ENCLOSURES

- A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key lock latch and removable sub panels. A single key shall be common to all field panels and sub panels.
- B. Interconnections between internal and face mounted devices shall be pre-wired with color coded stranded conductors neatly installed in plastic troughs and/or tie wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- C. Provide on/off circuit breaker with proper over current rating for control power sources to each local panel.

- D. All outside mounted enclosures shall meet the NEMA-4 rating.

PART 4 - EXECUTION

4.1 CONTRACTOR RESPONSIBILITIES

- A. General : Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.
- B. Demolition : Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor. The BAS sub-contractor will be responsible for maintaining any existing equipment throughout the phasing of the project and ensuring that existing control devices are functional until the time that they are removed.
- C. Code Compliance : All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.
- D. Cleanup : At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

4.2 WIRING, CONDUIT, AND CABLE

- A. All wire will be copper and meet the minimum wire size and insulation class listed below:

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

- B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
- C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

- D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 3/4 inch. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fittings, and galvanized rigid conduit where exterior conduits enter the building or between areas of high temperature/moisture differential.
- E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
- G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings.
 - 1. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.
- H. Fiber optic cable shall only be installed and terminated by an experienced network technicians. The BAS contractor shall submit to the Engineer verification of fiber termination testing.

4.3 HARDWARE INSTALLATION PRACTICES FOR WIRING

- A. The 120VAC power wiring provided by the electrical shall be a dedicated run to each control panel, with a separate breaker. A true earth ground must be available in the building. Corroded pipes, galvanized pipe, and structural steel must be certified to provide true earth grounding.
- B. Control cables are to be attached to the building at regular intervals such that the cables do not droop. Wires are not to be affixed to or supported only by pipes, conduit, etc.
- C. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
- D. Conduit, in non-finished areas will run parallel to or at right angles to the building structure.
- E. Cables are to be kept a minimum of three (3) inches from hot water, steam, refrigerant or condensate piping.
- F. Where sensor wires leave the conduit system, the edges of the conduit are to be protected by a plastic insert.

- G. Provide fire caulking at all rated penetrations.

4.4 INSTALLATION PRACTICES FOR FIELD DEVICES

- A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
- B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
- D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
- E. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
- F. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

4.5 IDENTIFICATION

- A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
- B. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.
- C. Junction box covers will be marked to indicate that they are a part of the BAS system.
- D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
- E. All I/O field devices inside FIP's shall be labeled.

4.6 EXISTING CONTROLS.

- A. Existing controls shall not be reused as party of the new systems. Existing controls which are to be found to be defective requiring construction will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair. The BAS sub-contractor will be responsible for maintaining any existing equipment throughout the phasing of the project and ensuring that existing control devices are functional until the time that they are removed.

4.7 CONTROL SYSTEM SWITCH-OVER

- A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.
- B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.
- C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.
- D. The BAS sub-contractor will be responsible for maintaining any existing equipment throughout the phasing of the project and ensuring that existing control devices are functional until the time that they are removed.

4.8 SENSOR AND DEVICE LOCATION

- A. The location of sensors and field devices is per mechanical and architectural drawings.
- B. Space humidity or temperature sensors will be mounted away from machinery generating heat, from direct sunlight and from diffuser air streams.
- C. Outdoor air sensors will be mounted on the outside of the north building. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

4.9 COLOR GRAPHIC DISPLAYS.

- A. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

4.10 REPORTS.

- A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:
 - 1. Trend comparison data (optional)
 - 2. Alarm status and prevalence information (optional)
 - 3. Energy Consumption data (optional)
 - 4. System user data (optional)

4.11 QUALITY ASSURANCE - SYSTEM STARTUP AND COMMISSIONING

- A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- B. The BAS contractor shall commission and set in the automatic operating condition as specified by the sequence of operations all major equipment and systems, such as the chilled water, hot water and all air handling systems, after the equipment has been manually started and tested and in the presence of the equipment manufacturer's representatives and the Owner and Architect's representatives as applicable.
- C. The BAS Contractor shall provide a technician for 2 days manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing hydronic and/or air systems in the building. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.
- D. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.
- E. Required elements of the startup testing include:
 - 1. Measurement of voltage sources, primary and secondary
 - 2. Verification of proper controller power wiring.
 - 3. Verification of component inventory when compared to the submittals.
 - 4. Verification of labeling on components and wiring.
 - 5. Verification of connection integrity and quality (no loose strands and good tight connections).
 - 6. Verification of bus topology, grounding of shields and installation of termination devices.
 - 7. Verification of point checkout.
 - 8. Each I/O device is landed per the submittals and has been verified to function as per the sequence of control.
 - 9. Analog sensors are properly scaled and a field verified value is correctly reported
 - 10. Binary sensors have the correct normal position and the state is correctly reported.
 - 11. Analog outputs have the correct normal position and move full stroke when so commanded.
 - 12. PID Loop control accuracy and stability of all analog control loops verified.
 - 13. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.

14. Written documentation of startup (measured value, reported value, date measured and tech name).
- F. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.
1. System access and Graphics navigation and setpoint adjustment
 2. Trend data collection and presentation.
 3. Alarm handling, acknowledgement and routing.
 4. Time schedule editing.
 5. Report and Trend Log viewing.
 6. Automatic backups and safe storage procedures
 7. Web-based Operator Workstations access.
- G. A final, written Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion and included in the Operations and Maintenance Manual.
- 4.12 OPERATION AND MAINTENANCE DOCUMENTATION (O&M)
- A. The O&M shall include checkout sheets where each I/O device (both field mounted as well as those located in control panels) shall be inspected and verified for proper installation and functionality. The checkout sheets shall itemize each device and shall be filled out, dated and approved by the checkout technician for inclusion in the O&M.
 - B. The O&M shall include field checkout documentation of all controllers and front end equipment (Workstations, servers, printers, Ethernet switches, etc.) and shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be included in the O&M.
 - C. The O&M shall include an As-programmed sequence of operations, the Sequence of Operations Commissioning and System Startup Report and an electronic copy of all databases, configuration files, and system balancing and acceptance reports by others.
- 4.13 TRAINING
- A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories. Training shall be provided on-site.

- B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give two 8-hour days of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:
1. Explanation of drawings and operator's maintenance manuals.
 2. Walk-through of the job to locate all control components.
 3. DDC Controller operation/sequence.
 4. Operator control functions including scheduling, alarming, and trending.
 5. Explanation of adjustment, calibration and replacement procedures.

END OF SECTION 230923

SECTION 230993 - HVAC CONTROL SEQUENCE

PART 1 - GENERAL:

1.1 DESCRIPTION OF THE WORK:

- A. Control Sequence is hereby defined to mean the manner in which, and methods by which, the automatic temperature controls function. The requirements for each type of operation are specified in this section.
- B. The operation equipment, devices and system components required for the automatic temperature control system are specified in Section 230923 of these specifications.

1.2 SUBMITTALS:

- A. Refer to Submittal Section in Section 230923 for additional information.
- B. General: Submittals on temperature control work are required for shop drawings, manufacturer's data, operating instructions, maintenance manuals, wiring diagrams and the system guarantee and product warranties.

PART 2 - CONTROLS

2.1 DAY-NIGHT INDEXING:

- A. A direct digital controller shall provide the automatic signals for occupied or unoccupied control. For each zone listed below, provide a software graphical user interface that allows authorized maintenance personnel to select or override the automatic signals for occupied or unoccupied control on the building management system user interface. An alarm shall be generated on the Facility Management System (FMS) when the Zone is selected as "Override". The new zones for this building shall be as follows:

1.	ZONE #	AREA SERVED
	a.	Cafeteria
	b.	Library
	c.	Gymnasium
	d.	Classrooms
	e.	Administration
	f.	Kitchen

- B. Whenever any zone is indexed to occupied cycle, the unit or units shall run continuously and shall be controlled as specified hereinafter. When indexed to the unoccupied cycle, the room sensors shall be reset to night temperature and shall cycle their respective units to maintain the setback or setup setpoints. In addition, whenever a classroom zone is indexed to the occupied cycle, the toilet exhaust fans shall operate. The toilet exhaust fans shall be off during the unoccupied cycle.

2.2 CYCLES:

- A. **Night (Unoccupied):** When any zone is indexed to the night cycle, all air handling units and rooftop units within the zone shall stop, all thermostats shall be indexed to their night setting and shall control their respective units to cycle the unit to maintain a reduced space temperature. During this cycle all associated exhaust fans shall be stopped and all associated outdoor and relief dampers shall be closed. When indexed to the occupied cycle, the units shall run continuously and shall be controlled as specified hereinafter. The automatic occupied - unoccupied signals shall incorporate an adaptive optimum start algorithm that shall utilize both the zone temperature and the outside air temperature to start the mechanical equipment so as to reach occupied temperature targets just in time for occupancy.
- B. **Day (Unoccupied):** When any zone is indexed to the day cycle, but the occupancy sensor describes the space as unoccupied, the space may go into a day-unoccupied cycle. During this cycle all associated outdoor dampers shall be closed and the unit shall run intermittently as required to maintain the space temperature. The temperature set-point shall be identical to the set-point in occupied mode. The occupied and unoccupied statuses shall be determined through a relay to the space's occupancy sensor. The sensor shall be provided by the E.C. with a relay for this connection. The connection and wiring to the BAS shall be provided by this Contractor.
- C. **Occupied:** When any zone is indexed to the day cycle, and the occupancy sensor describes the space as occupied, the space shall operate per the sequences described in the following sections.
- D. **Warm Up:** For all air conditioning units and air handlers, provide the necessary devices required to keep the outside air dampers closed during the warmup cycle prior to occupancy as determined by the optimum start algorithm.

2.3 HOT/CHILLED WATER INDOOR SINGLE ZONE VAV AIR HANDLING UNIT CONTROL

- A. Air handlers are equipped with outside air/return air dampers and hot water heating/chilled water coils with 2-way valve control. Air handler shall be indexed to the occupied, unoccupied-day, unoccupied-night and warmup modes from the Facility Management System (FMS) along with the respective zone.
- B. **Warmup Cycle:** When in the heating mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the air

handler on full heat and full return air in order to bring the temperature up to occupied set-point. Heating valve shall be open and outside air damper shall be closed.

C. Occupied Cycle:

1. The supply fan shall run continuously during the occupied cycle. The outdoor air damper shall first open to minimum position as set in the Facility Management System. In the heating mode, on a fall in space temperature below the heating set-point, the hot water valve (0-10V DC) shall modulate open through the coil while the outside air damper remains at minimum position. On a rise in space temperature, the hot water valve shall modulate closed.
2. On a continued rise in space temperature above the cooling set-point, the outside air damper shall modulate open for cooling. When in the cooling mode, the outdoor air damper shall be at minimum position and on a rise in space temperature, the chilled water valve (0-10V DC) shall be modulated open through the coil for cooling. On a fall in space temperature, the reverse shall occur.
4. If free cooling is not available, the outside air damper shall remain at minimum open position and just the chilled water valve shall be modulated open through the coil for cooling as required.
5. Dehumidification: Upon a rise in humidity above the space humidity set-point, the chilled water valve shall open through the coil and hot water reheat coil shall modulate to maintain space temperature. Upon a drop in space humidity, normal control shall be restored.

D. Unoccupied Cycle:

1. The outside air dampers shall remain closed while the fan cycles with the hot water and chilled water valves to maintain the adjustable setback set-points. During day, unoccupied mode the set-points shall not be setback.
2. Dehumidification: Upon a rise in humidity above the space humidity set-point, the 2 way chilled water valve shall open and the hot water coil valve shall modulate to maintain space temperature. Upon a drop in space humidity, normal control shall be restored.

E. Safeties:

1. During both occupied and unoccupied cycles, an averaging air temperature sensor shall act to override the heating coil face and bypass dampers and heating control valve as required in order to maintain the adjustable low limit set-point of 55 degF.
2. For units with capacity greater than or equal to 2000 CFM, duct smoke detector(s) shall be provided. Power wiring to duct detector(s) shall be and control shutdown wiring shall be provided. Upon sensing the products of combustion, the fan shall be de-energized, the outside air damper shall be closed, the heating and cooling shall be off and an alarm message shall be generated on the Facility Management System.
3. Provide a temperature low limit with 20' serpentine element responsive to the coldest 1' length in the discharge of the unit heating coil. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the unit heating coil control valve, close the

chilled water control valve and generate an alarm on the FMS. The low limit will not require a manual reset at the device before the unit can be restarted.

F. Room Sensors:

1. The room temperature sensor shall have a concealed setpoint adjustment knob with software definable adjustment range (e.g. +/- 2 degF).
2. Provide a carbon dioxide space sensor to monitor carbon dioxide levels and generate an alarm on elevated levels. The unit's outdoor air damper shall modulate closed below minimum when carbon dioxide levels are less than 800 ppm, unless the unit is in economizer operation mode.
3. All sensor inputs and actuator outputs from the controller shall be available throughout the Facility Management System.

2.4 ENERGY RECOVERY UNITS

- A. Energy recovery units are equipped with outside air/return air dampers, recirculation dampers, exhaust dampers, recovery device bypass dampers and hot water heating/chilled water coils with 3-way valve control. Units shall be indexed to the occupied, unoccupied and warmup modes from the Facility Management System (FMS) along with the respective zone.
- B. Fan Speed Control: For each system provide a supply duct static pressure sensor located 2/3 out the distance of the main supply air duct that shall act, through the DDC controller, to modulate the speed of the supply air fan via the VFD in order to maintain a constant supply duct static pressure. Unit shall always be started at minimum speed and ramp up gradually to the required airflow.
- C. Warmup Cycle: When in the heating mode, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the air handler on full heat and full return air in order to bring the spaces up to occupied set-point. Heating valve shall be open, and face damper shall be open to the coil and outside air damper shall be closed. VAV box dampers shall be fully open, but shall close on rising temperatures above the room set-point. The unit shall remain in heating mode until all spaces have reached their occupied set-points.
- D. Cool-Down Cycle: When in the cooling mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the air handling unit on full cooling and full return air in order to bring the space temperatures down to occupied set-point. Cooling valve shall be open, outside air damper shall be closed. If conditions are appropriate for economizing (as described in the occupied sequence) the economizer function shall be engaged. VAV box dampers shall be controlled to close on dropping temperature below the room set-point.
- E. Occupied Cycle:
 1. The supply fan shall run continuously during the occupied cycle. Fan operation shall be proved. After fan operation is proved, the outdoor air damper shall first open to

- minimum position as set in the Facility Management System. On a fall in supply air temperature below the heating set-point, the hot water valve shall modulate open and the outside air damper remains at minimum position. On a rise in supply air temperature, the hot water valve shall modulate closed.
2. The supply air temperature shall optimized to satisfy the room with the largest cooling demand.
 3. Whenever the outside air temperature falls below 38 degF, the hot water control valve shall open fully and only the face and bypass dampers shall be modulated as required to maintain the heating set-point. Whenever the outside air temperature rises above 40 degF, the face damper shall fully open, the bypass damper shall fully close and the hot water heating control valve shall be modulated as required to maintain the heating set-point.
 4. On a continued rise in space temperature above the cooling set-point, the outside air damper shall modulate open for cooling. When in the cooling mode, the outdoor air damper shall be at minimum position and on a rise in space temperature, the chilled water valve shall be modulated open for cooling. On a fall in space temperature, the reverse shall occur.
 5. If free cooling is not available as determined by outdoor air enthalpy, the outside air damper shall remain at minimum open position and just the chilled water valve shall be modulated open for cooling as required.
- F. Unoccupied Cycle: The outside air dampers shall remain closed while the fan cycles with the hot water valve and chilled water valve to maintain the adjustable setback and setup set-points at a designated night zone temperature sensor. VAV box dampers shall be fully open, but shall close on rising temperatures above the room set-point. Onoccupied dehumidification sequence shall follow the Discharge Air Temperature Reset Control specification (H-8 & H-9).
- G. Safeties:
1. During both occupied and unoccupied cycles, an averaging air temperature sensor shall act to override the heating coil face and bypass dampers and control valve as required in order to maintain the adjustable low limit set-point of 55 degF.
 2. For units with capacity greater than or equal to 2000 CFM, duct smoke detector(s) shall be furnished by the Electrical Contractor and installed by the Heating Contractor. Power wiring to duct detector(s) shall be provided by the Electrical Contractor and control shutdown wiring shall be provided by the FMS Contractor. Upon sensing the products of combustion, the fan shall be de-energized, the outside air damper shall be closed, the return air damper opened, the heating opened, and cooling coil closed, and an alarm message shall be generated on the Facility Management System.
 3. Provide a temperature low limit with 20' serpentine element responsive to the coldest 1' length where indicated on the ATC schematics. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the return air damper, open the unit heating coil control valve, close the chilled water control valve and generate an alarm on the FMS. The low limit will require a manual reset at the device before the unit can be restarted.
 4. All sensor inputs and actuator outputs from the controller shall be available throughout the Facility Management System.

H. Discharge Air Temperature Reset Control:

1. At a frequency of once every 10 minutes, the BAS shall monitor the outdoor dry-bulb temperature, as well as the zone temperature and damper position of all FPV and VAV terminal units.
2. The BAS shall calculate a new SAT set-point based on current outdoor air (OA) temperature, and send this newly-calculated SAT setpoint to the AHU controller.
3. When the OA temperature is warmer than 65°F (adj), the SAT set-point shall be 55°F (adj).
4. When the OA temperature is colder than 55°F (adj), the SAT set-point shall be 60°F (adj).
5. When the OA temperature is between 55°F (adj) and 65°F (adj), the SAT set-point shall be reset proportionally between 55°F (adj) and 60°F (adj).
6. If at least two (adj) zones have both 1) a FPV/VAV damper that is more than 75% open, and 2) a current zone temperature that is higher than the current cooling set-point, then the SAT set-point shall return to 55°F (adj).
7. If the outdoor dew point is higher than 60°F (adj), this SAT Reset sequence shall be suspended and the SAT set-point shall be reset to 55°F (adj) until outdoor dew point drops below 57°F (adj).
8. If return humidity rises above 50% (adj.), the unit will ignore any discharge air temperature reset sequence and discharge a constant 50°F (adj.).
9. Once return air humidity drops 5% below set-point the unit can follow the discharge air temperature reset sequences that are outlined.

- I. Filter Status: A pressure switch will monitor the differential pressure across the filter when the supply fan is operating. If the switch closes for 2 minutes after a request for fan operation, a dirty filter alarm will be annunciated.

- J. Discharge Duct Static Pressure Control: At a frequency of once every 10 minutes, the BAS shall monitor the damper position of all VAV terminal units. The BAS shall calculate a new supply fan duct static pressure setpoint based on the position of the furthest-open VAV damper, and send this newly-calculated setpoint to the AHU controller. When any VAV damper is more than 75% (adj) open, the supply fan duct static pressure setpoint shall be reset upward by 5% until no damper is more than 75% (adj) open or the static pressure setpoint has reset to the maximum setting. When all VAV dampers are less than 65% (adj) open, the supply fan duct static pressure setpoint shall be reset downward by 5% until at least one damper is more than 65% (adj) open or the static pressure setpoint has reset to the minimum setting.

K. Room Sensors:

1. All sensor inputs and actuator outputs from the controller shall be available throughout the Direct Digital Control System.

- L. Supply and Exhaust Fan Operation: A pressure switch will monitor the differential pressure across each fan. If the switch does not open within 30 seconds after a request for fan operation, a fan failure alarm will be annunciated and the ERU will stop, requiring a manual reset to re-start the ERU. If the supply duct static pressure reaches 5.0 in.H2O

(adj), the high limit pressure switch will shut down the ERU, requiring a manual reset to re-start the ERU.

2.5 SHUTOFF VAV BOX CONTROL:

- A. The VAV box is to be controlled independent of system pressure fluctuations by an application specific DDC controller using electric actuation. The space served by the VAV box is controlled in Occupied and Unoccupied as indexed by the FMS according to its respective zone signal.
- B. During the unoccupied cycle the VAV box primary air damper shall be allowed to be fully closed. During day-unoccupied mode the set-points shall not be setback.
- C. During the Occupied cycle, the VAV box primary air damper is controlled within user defined occupied maximum and minimum supply air volume settings. The controller monitors the room temperature sensor and air velocity sensor and modulates the primary supply air damper in sequence with the hot water reheat coil control valve to maintain the room temperature at set-point. While the reheat coil is being utilized for heating, the box primary supply damper shall remain at the minimum design CFM. When the boilers are not in operation, the air flow minimum setting shall be zero and reheat shall not be used.
- D. Room Sensors:
 - 1. The room temperature sensor shall have a concealed set-point adjustment slide knob with software definable adjustment range. The room sensor shall have no indication of room temperature readout. The set-point adjustment slide knob shall read + for warmer and - for cooler and shall be color coded red for warmer and blue for cooler.
 - 2. All sensor inputs and actuator outputs from the controller shall be available throughout the Direct Digital Control System.

2.6 EXHAUST FAN CONTROL:

- A. Those exhaust fans noted "Occ/Unocc" on the Exhaust Fan schedule shall run during occupied cycle and remain off during unoccupied cycle of their respective zone. The exhaust fans shall be controlled via spare binary outputs of local DDC controllers such that they can be overridden on/off through the Facility Management System.
- B. Those exhaust fans noted "T'stat" on the schedule shall be controlled based upon a space temperature sensor via the DDC system. Upon a rise in space temperature, the exhaust fan shall run and any associated intake or exhaust dampers shall open (where applicable). On a fall in space temperature, the reverse shall occur.
- C. For exhaust fans associated with a kitchen hood provide all necessary wiring, switches and interlocks to energize the fan from a switch located on the exhaust hood. Fans shall

also be energized by a heat sensor located in the kitchen hood. All sensors, relays, and wiring required for a complete system shall be provided by this Contractor. "All" includes the lights and line voltage wiring.

- D. Those exhaust fans noted "Switch" fan shall be operated by a manual on/off switch provided by the H.C. and installed by the E.C. A separate thermostat will be provided where noted on the schedule drawings. If high temperatures are sensed in the exhaust fan shall energize regardless of the status of the manual switch.

2.7 CABINET UNIT HEATER CONTROL:

- A. Provide a remote space temperature sensor for control of each cabinet unit heater. The sensor shall be controlled through the DDC system and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall cycle the cabinet heater fan to maintain the day or night temperature set-point. Any time that the unit fan is energized, the two position hot water control valve shall open.

2.8 UNIT HEATER CONTROL:

- A. Provide a remote space temperature sensor for control of each unit heater. The sensor shall be controlled through the DDC system and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall cycle the heater fan to maintain the day or night temperature set-point. Any time that the unit fan is energized, the two position hot water control valve shall open.

2.9 CONVECTOR CONTROL:

- A. Provide a remote space temperature sensor for control of each convector. The sensor shall be controlled through the DDC system and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall open the two-position hot water control valve to maintain the day or night temperature set-point.

2.10 DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS:

- A. Install and wire the thermostat provided by the unit manufacturer. In each area provide a temperature sensor to generate an alarm on the FMS if elevated temperatures are sensed.

2.11 HEATING PUMPS:

- A. The heating pump pair shall be commanded to run continuously through the FMS according to the lead/lag control described in 2.12.
- B. The speed of the pump will be modulated through the FMS to maintain the differential pressure set-point at two locations out in the chilled water system . Upon lead pump failure and after an adjustable time delay; the lag pump will be energized and the lead pump will be locked out. An alarm will be recorded and annunciated at the operator work station. The lead pump will be selectable from the FMS panel.

2.12 LEAD/LAG SELECTION OF HOT WATER AND CHILLED WATER PUMPS:

- A. Lead pump selection shall be through manual 3-position switches (e.g. Pump 1 - Off - Pump 2) on the boiler room ATC panel. Upon lead pump failure as sensed by a water flow switch and after an adjustable time delay, the lag pump shall be energized and the lead pump shall be locked out either through the starter or the respective VFD. An alarm shall be generated on the mechanical room DDC panel. Also, an alarm message shall be generated on the FMS network. Pump commands, lead pump selection and flow statuses shall be available throughout the network. Lead/Lag shall be alternated by the Building Management System on a weekly basis.

2.13 BOILERS:

- A. When the heating system is energized, the lead main heating pump shall operate. The control valve on the lead boiler shall open and the lead boiler shall be commanded to operate. Provide a signal to the boiler to control the percentage of firing to maintain the desired loop temperature as follows:
 - 1. 35 F and lower outdoor air temperature - 140 F water temperature (adjustable).
 - 2. 70 F and higher outdoor air temperature - 120 F water temperature (adjustable).
- B. Should the lead boiler fail to maintain the scheduled temperature, open the valve for the lag boiler, and energize the lag boiler to maintain the scheduled loop water temperature, de-energize the lead boiler, close its control valve, and generate an alarm on the FMS.
- C. Communication to the boilers shall be via the boilers' port. The boiler manufacturer shall provide a gateway for communicating with this port if required. Mechanical Contractor shall coordinate the protocol between manufacturer and ATC subcontractor.
- D. Display all points available from the boilers on the FMS.

2.14 CARBON MONOXIDE SENSOR:

- A. Provide a carbon monoxide detection panel with remote sensor in the boiler room. Panel shall generate a local audible and visual alarm. Remote alarms shall be provided

and shall be visual only. Generate an alarm on the FMS should carbon monoxide be sensed.

2.15 NATURAL GAS LEAK DETECTION PANEL:

- A. Provide a natural gas leak detection panel and 2 remote sensors in the boiler room. Panel shall generate an alarm on the FMS should natural gas be sensed. Shut down all gas fired equipment if a leak is detected.

2.16 BURNER KILL SWITCHES:

- A. Provide two (2) burner kill switches. When any of the switches are switched to the off position the boilers shall be de-energized and an alarm shall be generated on the FMS.

2.17 THERMOSTAT GUARDS:

- A. Provide guards over thermostats in vestibules, cafeteria, gymnasium, corridors, student toilet rooms, and other similar unsupervised spaces.

2.18 ALARMING:

- A. Any alarm that the Owner defines as critical shall initiate an alarm to the remote Operator Workstation and shall generate an alarm message there. Utilize the District's Ethernet communications and data system.

2.19 CHILLER PLANT:

- A. The chiller plant shall be enabled by the FMS whenever the outside air temperature is 60°F (Adjustable). or above and systems in the facility are in the OCCUPIED mode of operation. On a fall in outside air temperature below 55° F(Adjustable), the chilled water plant will be disabled (Chillers, and Pumps Off).
- B. Chilled Water Pumps: When the chiller plant is enabled, the chilled water pumps shall be enabled. The speed of the chilled water pump will be modulated through the FMS to maintain the differential pressure set-point at two locations out in the chilled water system . Upon lead pump failure and after an adjustable time delay; the lag pump will be energized and the lead pump will be locked out. An alarm will be recorded and annunciated at the operator work station. The lead pump will be selectable from the FMS panel.
- C. Control :
 - 1. Chiller, once enabled, shall operate under control of their manufacturer installed control system. Flow shall be proven in the chilled water system before a chiller is started.

2. The chiller control system shall be interfaced to the FMS system via a Bacnet interface provided by the chiller manufacturer.
3. The interface shall pass alarms generated by the chiller control system to the FMS.
4. The chilled water set-point shall be a writeable point on the FMS.

2.20 EMERGENCY GENERATOR:

- A. Interface with the generator system to provide a summary alarm on the FMS to indicate failure or trouble alarms. Indicate when the generator is operating.
- B. Provide time delay relays to stagger start-up of equipment on emergency power according to the following schedule:
 1. Step 1 (Instantaneous) Emergency Lights, Fire Alarm, Intercom, IDF/MDF Equipment, ATC Control Panels
 2. Step 2 (30 Second Delay) Boilers, Heating Pumps, Boiler Control Panel
 3. Step 3 (30 Second Delay) IDF/MDF DSS/CU, Heat Trace to CHL, CHL Basin Heater, Cabinet Heater Fans, Unit Heater Fans, ERU-2, ERU-3, AHU-1.

2.21 VARIABLE FREQUENCY DRIVES:

- A. Monitor status of drive for HOA position and drive output.
- B. Provide alarm if drive is in the hand position.

2.22 FAN COIL UNIT:

- A. Fan coil units are equipped with supply fans, hot water re-heat coils, chilled water cooling coils, and return air filters. Fan coils shall be indexed to the occupied, unoccupied, warmup, and cool-down modes from the Building Automation System (BAS) along with the respective zone.
- B. Warmup Cycle: When in the heating mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the unit on full heat in order to bring the temperature up to occupied set-point. Heating valve shall be open and modulate closed as the space reaches temperature.
- C. Cool-Down Cycle: When in the heating mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the unit on full cooling in order to bring the temperature down to occupied set-point. Cooling valve shall be open and modulate closed as the space reaches temperature.
- D. Occupied Cycle:

1. The supply fan shall run continuously during the occupied cycle.
2. On a fall in space temperature below the heating set-point, the hot water valve shall modulate open. On a rise in space temperature, the hot water valve shall modulate closed.
3. On a further rise in space temperature, the chilled water valve shall modulate open.
4. When space humidity exceeds 60% (adjustable) the chilled water valve shall fully open and the heating water valve shall modulate to maintain space temperature.

E. Unoccupied Cycle:

1. The fan shall cycle with the hot water and chilled water valves to maintain the adjustable setback set-points.

F. Room Sensors:

1. All sensor inputs and actuator outputs from the controller shall be available throughout the Building Automation System.

- G. Filter Status: A pressure switch will monitor the differential pressure across the filter when the supply fan is operating. If the switch closes for 2 minutes after a request for fan operation, a dirty filter alarm will be annunciated.

2.23 DOMESTIC HWH:

- A. Provide a temperature sensor in the domestic water supply piping at the outlet of the water heaters to monitor temperature and indicate an alarm on the BAS if abnormal temperature is sensed. Interface to BACnet gateway provided by water heater manufacturer.

2.24 HEAT TRACE:

- A. Provide a current sensing relay on each heat trace circuit to indicate status on the BAS.

2.25 FAN POWERED VAV BOX CONTROL

- A. The fan powered VAV box is to be controlled independent of system pressure fluctuations by an application specific DDC controller using electric actuation. The space served by the FPV box is controlled in Occupied and Unoccupied as indexed by the BAS according to its respective zone signal.
- B. During the Occupied cycle, the FPV box fan shall run continuously and the box primary air damper is controlled within user defined occupied maximum and minimum supply air volume settings. The controller monitors the room temperature sensor and air velocity sensor and modulates the primary supply air damper in sequence with the reheat valve to maintain the room temperature at set-point. While the reheat coil is being utilized for

heating, the box primary supply air damper shall remain at the minimum design CFM. When the boilers are not in operation, the air flow minimum setting shall be zero and reheat shall not be used. Where fin tube radiation occurs, the radiation shall serve as the first stage of heat.

- C. During the Unoccupied cycle, the FPV box fan cycles to maintain night setback temperature at the zone temperature sensor, the FPV box's damper shall be closed to primary airflow and the reheat control valves shall modulate to maintain set-point temperature.
- D. Room Sensors:
 - 1. The room temperature/humidity sensor shall have a setpoint adjustment knob with a software definable adjustable range.
 - 2. All sensor inputs and actuator outputs from the controller shall be available throughout the Building Automation System.

2.26 OUTSIDE AIR INTAKE SCHEDULE:

- A. Outside air intakes shall be provided with an ATC damper. The damper shall open when the associated space is occupied and close when the associated space is unoccupied. Damper shall be linked to the freezestat to close when abnormally low temperatures are sensed per the sequences above.

PART 3 - EXECUTION:

3.1 INSTALLATION:

- A. Refer to the 250554 section of these specifications.

3.2 TEST-ADJUST-BALANCE (TAB) COORDINATION AND ASSIST:

- A. Include all labor for coordination and assistance to the TAB contractor for final system testing, adjusting and balancing.

END OF SECTION 230993

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SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Chilled water piping, above grade.
- D. Chilled water piping, below grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, mechanical couplings, and dielectric connections.
- G. Valves:
 - 1. Gate valves.
 - 2. Ball valves.
 - 3. Butterfly valves.
 - 4. Check valves.

1.2 RELATED REQUIREMENTS

- A. Section 099000 - Painting and Coating.
- B. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
- C. Section 230719 - HVAC Piping Insulation.
- D. Section 232114 - Hydronic Specialties.
- E. Section 232500 - HVAC Water Treatment:

1.3 REFERENCE STANDARDS

- A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2013.

- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers; 2011.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; 2013.
- E. ASME B31.9 - Building Services Piping; 2011 (ANSI/ASME B31.9).
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2011a.
- H. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2009).
- I. ASTM B32 - Standard Specification for Solder Metal; 2008.
- J. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.
- K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005 (Reapproved 2011).
- L. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2012.
- M. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2009.
- N. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2013.
- O. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2006.
- P. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- Q. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- R. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2013a.
- S. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007.

- T. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; 2011 and errata.
- U. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2010.
- V. AWWA C606 - Grooved and Shouldered Joints; 2011 (ANSI/AWWA C606).
- W. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME (BPV IX).
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalogue information.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements, for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.
- C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

- D. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- E. Coupling Manufacturer:
 - 1. Victaulic
 - 2. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 3. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
- F. Welder Qualifications: Certify in accordance with ASME (BPV IX).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever joining dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.

- b. Grooved mechanical connections and joints shall be Victaulic Zero Flex (rigid) couplings only.
 - c. Use for couplings, tees, reducers, and elbows only.
 - d. Provide proper gaskets for system working temperature and pressure.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated and as follows:
- 1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

2.2 PEX PIPE AND FITTINGS

- A. Use is limited to 2 inch size and smaller.
- B. PEX-a (Engle-method Crosslinked Polyethylene) Piping: ASTM 876 with oxygen-diffusion barrier that meets DIN 4726.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Uponor Wirsbo hePEX or a comparable product by one of the following:
- 1. Rehau
 - 2. Mr. PEX
- D. PEX-a Fittings, Elbows and Tees (½ inch through 2 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
- 1. UNS No. C69300 Lead-free (LF) Brass
 - 2. 20% glass-filled polysulfone as specified in ASTM D6394
 - 3. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394
 - 4. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
 - 5. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394
 - 6. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".

E. TRANSITION FITTINGS

1. Plastic-to-Metal Transition Fittings:
 - a. Manufacturers: Provide fittings from the same manufacturer of the piping.
 - b. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Editor: Use for PEX sizes 2 inch and below.
 - c. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Use for PEX sizes 2 inch and below.
 - d. Dezincification-resistant (DZR) Brass to PEX-a Transition: male NPT thread and PEX compression fitting. Use for PEX sizes 2½ inch through 4 inch.

2.3 TRANSITION UNIONS

A. Plastic-to-Metal Transition Unions:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. Threaded Brass to PEX-a Union: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Use for PEX sizes 2 inch and below.
3. Brass Sweat to PEX-a Union: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Use for PEX sizes 2 inch and below.

2.4 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings. 2 inch size and smaller.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings. Groove joints shall be as manufactured by Victaulic.

B. Copper Tube up to 2 inch size only: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.

2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, non toxic synthetic rubber sealing elements.

C. Manufacturers:

1. Grinnell Mechanical Products, a Tyco International Company: www.grinnell.com.
2. Viega LLC: www.viega.com.
3. Nibco

D. PEX Piping:

1. Hot-water heating piping, aboveground (2 inch and below) shall be the following:
 - a. PEX-a piping, with F1960 cold-expansion fittings.

2.5 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:

1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings. 2 inch size and smaller.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings. Grooved joints shall be as manufactured by Victaulic.

B. Copper Tube up to 2 inch size only: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, non toxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Grinnell Mechanical Products, a Tyco International Company: www.grinnell.com.
 - 2) Viega LLC: www.viega.com.
 - 3) Nibco

C. PEX Piping:

1. Chilled water piping, aboveground (2 inch and below) shall be the following:
 - a. PEX-a piping, with F1960 cold-expansion fittings.
2. Hot-water heating piping, aboveground (2½ inch through 4 inch) shall be the following:
 - a. PEX-a piping, with compression fittings.

2.6 CHILLED WATER PIPING, BURIED

- A. PVC Pipe: ASTM D 1785, Schedule 40, or ASTM D 2241, SDR 21 or 26.
 1. Fittings: ASTM D 2466 or ASTM D 2467, PVC.
 2. Joints: Solvent welded.
- B. PVC Pipe sizes 8 inch (200 mm) and larger: ASTM D 1785, Schedule 80, or ASTM D 2241, SDR 21 or 26.
 1. Fittings: ASTM D 2466 or ASTM D 2467, PVC.
 2. Joints: Solvent welded.

2.7 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
- B. PVC Pipe: ASTM D1785, Schedule 40. Do not use in air plenum spaces.
 1. Fittings: ASTM D2466 or D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.

2.8 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Under:
 1. Ferrous Piping: 150 psig malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe Over 2 Inches:
 1. Ferrous Piping: 150 psig forged steel, slip-on.
 2. Gaskets: 1/16 inch thick preformed neoprene.

- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 - 4. Gasket Material: EPDM suitable for operating temperature range from -30 degrees F to 230 degrees F.
 - 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 - 7. Manufacturers:
 - a. Victaulic Company: www.victaulic.com.
- D. Dielectric Connections:
 - 1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600 volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.

2.9 GATE VALVES

A. Manufacturers:

- 1. Nibco, Inc: www.nibco.com.
- 2. Crane.
- 3. Stockham
- 4. Victaulic

B. Over 3 Inches:

- 1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

2.10 BALL VALVES

A. Manufacturers:

- 1. Nibco, Inc: Model #580-70-66: www.nibco.com.
- 2. Crane
- 3. Stockham
- 4. Victaulic Company: www.victaulic.com.

B. Up to and including 3 inches:

1. Bronze two piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends with union.
2. Provide Nib-seal with extended handles for chilled water lines.

2.11 BUTTERFLY VALVES

A. Manufacturers:

1. Nibco #3010
2. Crane Co.
3. Jamesbury
4. Victaulic

B. Body: Ductile iron with resilient replaceable EPDM seat, lug ends, extended neck, extended neck, 250 psi.

C. Disc: Construct of chrome plated ductile iron.ASTM A-395.

D. Stem: Stainless steel with stem offset from the centerline to provide full 360 degree circumferential setting.

E. Operator: Infinite position lever handle with memory stop. Over 6" size, gear operator.

F. Contractor shall include an allowance for four additional 4" butterfly valves.

2.12 SWING CHECK VALVES

A. Manufacturers:

1. Nibco, Inc: www.nibco.com.
2. Crane
3. Stockham
4. Victaulic Company: www.victaulic.com.

B. Up To and Including 2 Inches:

1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.

C. Over 2 Inches:

1. Iron body, bronze trim, bronze swing disc, renewable disc and seat, flanged ends.

2.13 CALIBRATED BALANCING VALVES:

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Bell & Gossett Model CS Plus

C. Armstrong Pump Model CBV

D. Flow Design Inc. Model UA

E. Nutech Model MB/MBF/MBG

F. Victaulic/Tour & Anderson STA Series.

1. Venturi Type Balancing Valves : 1/2" to 2"

a. Venturi type design, bronze body, chrome plated ball, EPDM seals. Provide pressure and temperature test ports across valve measurement area. Ports to be fitted with dual durometer EPDM cores, brass cap and O-ring seal. Valves to have drain/purge port. Valve end connections to suit the piping system. Provide valve with memory stop and calibrated position indicator. Valves to be rated at 600 PSI at 2500 F. and be 100% positive shut-off. Measurement accuracy to be +/-3% of flow rate.

2. Venturi Type Balancing Valves :2-1/2" to 12"

a. Venturi type design, cast carbon steel/ductile iron body, SS stem, EPDM seat and Buna seals. Provide memory stop and calibrated position indicator. Valves to be rated at 200 PSIG at 250F. and be 100% positive shut-off. Measurement accuracy to be +/-3 of flow rate.

3. Stainless for pool water system.

4. Globe Style Valves 1/2" to 2": to have Y-pattern, Ametal® brass copper alloy body providing dielectric protection rated to 300 PSI at 250 deg F. EPDM o-ring seals, 4-turn digital readout hand wheel for balancing and concealed memory feature with locking, tamper-proof setting. Built-in check valve provided for connecting a portable differential pressure meter for flow reading capabilities, soldered or threaded ends. Valve does not require a separate shutoff valve. Victaulic/Tour & Anderson Series 786, 787, and 78K.

a. Coil Components: Install Victaulic Series 78U or Nutech series URP/US union port fitting with manual air vent, PT tap and or drain valve, Victaulic Series 78Y or Nutech series SV strainer/ball valve with PT tap & drain valve with cap and strap or Victaulic Series 78T or Nutech series SB union/ball valve combination with PT and drain valve with cap & strap to complete terminal hookup at coil outlet. (Note: 78T or SB only to be used when 78Y or SV is not required).

b. Globe Style Valves 2-1/2" to 16": to have Y-pattern ductile iron body rated to 350 PSI at 250 deg F. EPDM o-ring seals, multiple-turn digital

readout hand wheel for balancing and concealed memory feature with locking, tamper-proof setting. Built-in check valve provided for connecting a portable differential pressure meter for flow reading capabilities, grooved or flanged ends. Valve does not require a separate shutoff valve. Victaulic/Tour & Anderson Series 788 and Series 789.

- c. Installer shall consult with Victaulic representative for proper presetting of valve to provide designed flows. Note: If using Nutech products no presetting is required.
 - 1) Schedule: Balancing Valves/Coil Kits: Supplier to provide complete schedule with product selection, valve sizes (which shall be the same as the pipe size), flow rates and differential pressure at design flow for each location/coil.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls and floors.

- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 7.
- H. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
 - 1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.

3.3 GROOVED JOINTS:

- A. Install in accordance with the manufacturer's latest published installation instructions.
- B. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.

3.4 INSERTS:

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 1. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.5 PIPE HANGERS AND SUPPORTS:

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-89.
- B. Support horizontal piping as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.

- E. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping.
- I. Prime coat exposed steel hangers and supports. Refer to Division 9. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- K. Use eccentric reducers to maintain top of pipe level.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- M. Install valves with stems upright or horizontal, not inverted.

3.6 SCHEDULES

A. Hanger Spacing for Copper Tubing.

- 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
- 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
- 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Steel Piping.

- 1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
- 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
- 6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
- 7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- 8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
- 9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.

C. Hanger Spacing for Plastic Piping.

1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.

D. Hanger Spacing for PEX Piping:

1. PEX-a Piping Hanger Spacing: Install hangers for PEX-a piping with the following maximum spacing:
 - a. 1 inch and below: Maximum span, 32 inches.
 - b. 1¼ inch and above: Maximum span, 48 inches.
2. PEX-a Piping Hanger Spacing with PEX-a Support Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations, with the following maximum spacing:
 - a. 1. Maximum span, 8 feet.
3. PEX-a Riser Supports: Install CTS riser clamps at the base of each floor and at the top of every other floor. Install mid-story guides between each floor.

E. PEX PIPE JOINT CONSTRUCTION

1. PEX-a Connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for F1960 connections.

F. PEX PIPE FIELD QUALITY CONTROL

1. Do not expose PEX piping to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of piping exposed to direct sunlight.

G. PEX PIPE WARRANTY

1. PEX-a manufacturer system warranty shall cover tubing for a duration of 30 years from the date of installation.

END OF SECTION 232113

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SECTION 232114 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Combination pump discharge valves.
- G. Balancing valves.
- H. Flow meters.
- I. Relief valves.
- J. Pressure reducing valves.

1.2 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 25 00 - HVAC Water Treatment: Pipe Cleaning.

1.3 REFERENCE STANDARDS

- A. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2013.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

- C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Maintenance Contract.
- F. Project Record Documents: Record actual locations of flow controls.
- G. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com.
 - 2. ITT Bell & Gossett: www.bellgossett.com.
 - 3. Taco, Inc: www.taco-hvac.com.
- B. Construction: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.

- C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.2 AIR VENTS

A. Manufacturers:

- 1. ITT Bell & Gossett: www.bellgossett.com.
- 2. Taco, Inc: www.taco-hvac.com.
- 3. Amtrol

- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

2.3 AIR SEPARATORS

A. Combination Air Separators/Strainers:

- 1. Manufacturers:
 - a. Armstrong International, Inc: www.armstronginternational.com.
 - b. ITT Bell & Gossett: www.bellgossett.com.
 - c. Taco, Inc: www.taco-hvac.com.
- 2. Steel, tested and stamped in accordance with ASME (BPV VIII, 1); for 125 psi operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 STRAINERS

A. Manufacturers:

- 1. Armstrong International, Inc: www.armstronginternational.com.
- 2. Green Country Filtration.
- 3. WEAMCO

B. Size 2 inch and Under:

- 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:

- 1. Provide flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:

2.5 SUCTION DIFFUSERS

A. Manufacturers:

1. ITT Bell & Gossett; www.bellgossett.com.
2. Victaulic Company of America; www.victaulic.com.

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.6 COMBINATION PUMP DISCHARGE VALVES

A. Manufacturers:

1. ITT Bell & Gossett
2. Crane Co.: www.cranevalve.com.
3. Taco, Inc: www.taco-hvac.com.
4. Victaulic Company of America: www.victaulic.com.

B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.7 FLOW METERS

A. Manufacturers:

1. ITT Bell & Gossett
2. Approved equal

B. Orifice principle by-pass circuit with direct reading gage, soldered or flanged piping connections for 125 psi working pressure, with shut off valves, and drain and vent connections.

C. Direct reading with insert pitot tube, threaded coupling, for 150 psi working pressure, maximum 240 degrees F, 5 percent accuracy.

- D. Calibrated, plug type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer.
- E. Portable meter consisting of case containing one, 3 percent accuracy pressure gage with 0-60 feet pressure range for 500 psi maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

2.8 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.9 PRESSURE REDUCING VALVES

- A. Manufacturers:

- 1. Armstrong International, Inc; Model www.armstronginternational.com.
 - 2. ITT Bell & Gossett; Model www.bellgossett.com.

- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 21 13.

- C. Materials of Construction:

- 1. Valve Body: Constructed of bronze.
 - 2. Internal Components: Construct of stainless steel and engineered plastics or composition material.

- D. Connections:

- 1. NPT threaded: 0.50 inch, or 0.75 inch.

- E. Provide integral check valve and strainer.

- F. Maximum Inlet Pressure: 100 psi.

- G. Maximum Fluid Temperature: 180 degrees F.

- H. Operating Pressure Range: Between 10 psi and 50 psi.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide valved drain and hose connection on strainer blow down connection.
- F. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- G. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- H. Support pump fittings with floor mounted pipe and flange supports.
- I. Pipe relief valve outlet to nearest floor drain.
- J. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 232114

SECTION 232117 - PIPE HANGERS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This section specified hangers, supports and anchors for use in piping systems installed in other sections of these specifications.

1.2 RELATED SECTIONS:

- A. Section 23 2113 - Hydronic Piping

PART 2 - PRODUCTS

2.1 HORIZONTAL PIPING HANGERS AND SUPPORTS:

- A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information: size hangers and supports properly for piping including insulation, if any.
- B. Adjustable Band Hangers: MSS Type 7, fabricated from steel.
- C. Adjustable Swivel Band Hangers: MSS Type 10.
- D. Clamp: MSS Type 4.
- E. Double Bolt Clamp: MSS Type 3, including pipe spacers.

2.2 VERTICAL PIPING CLAMPS:

- A. General: Except as otherwise indicated, provide factory fabricated vertical piping clamps of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection as determined by the installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size clamps properly for piping, including insulation (if any).
- B. Two Bolt Riser Clamp: MSS Type 8.

2.3 HANGER ROD ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory fabricated hanger rod attachments of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by installer for installation requirements, and comply with MSS AP-69 and the manufacturer's published product information. Size attachments properly for piping, including insulation (if any).
- B. Turnbuckles: MSS Type 13.
- C. Weldless Eye Nut: MSS Type 17.
- D. Malleable Eye Socket: MSS Type 16.
- E. Clevises: MSS Type 14.

2.4 BUILDING ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory fabricated building attachments of the MSS type and load rating indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or load rating is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published information. Size units properly for piping loading.
- B. Concrete Inserts: MSS Type 18, steel.
- C. Top Beam C-Clamps: MSS Type 19.
- D. C-Clamps: MSS Type 23, steel
- E. Top I-Beam Clamp: MSS Type 25.
- F. Side Beam Clamp: MSS Type 20.
- G. Beam Clamp/Eye Nut: MSS Type 28.
- H. Wide Flange Beam Clamp/Eye Nut: MSS Type 29.
- I. Beam Clamp/Extension Piece: MSS Type 30.

2.5 SADDLES AND SHIELDS:

- A. General: Except as otherwise indicated, provide factory fabricated saddles and shields of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size saddles and shields properly for insulation and vapor barriers (if any).
- B. Protection Saddles: MSS Type 39.
- C. Protection Shields: MSS Type 40.
- D. Wood Insulation Saddle: Provide products manufactured by Elcen Metal Products Company.

2.6 MISCELLANEOUS MATERIALS:

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

PART 3 - EXECUTION

3.1 PREPARATION:

- A. Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building attachments.

3.2 INSTALLATION OF BUILDING ATTACHMENTS:

- A. Install building attachments at the required locations within concrete or onto structural steel for proper piping support. Space attachments within the maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the top of inserts. Prior to placing concrete, install nut in insert and screw threaded rod thru nut until rod is firmly against top of the insert body.

3.3 INSTALLATION OF HANGERS AND SUPPORTS:

- A. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire of perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
- C. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.

3.4 PROVISIONS FOR MOVEMENT:

- A. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
- B. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 1. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.
- C. Insulated Piping: Comply with the following installation requirements:
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Shields: Where low compressive strength insulation of vapor barriers are indicated on cold water piping, install coated protective shields.
 - 3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.5 HYDRONIC PIPING

- A. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP 89.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2". Malleable iron adjustable swivel, split ring.

- C. Hangers for Cold Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.
- D. Hangers for Hot Pipe Sizes 2 to 4". Carbon steel, adjustable, clevis.
- E. Hangers for Hot Pipe Sizes 6" and Over: Adjustable steel yoke, cast iron roll, double hanger.
- F. Multiple or Trapeze Hangers. Steel channels with welded spacers and hanger rods.
- G. Multiple or Trapeze Hangers for Hot Pipe Sizes 6" and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
- H. Wall Support for Pipe Sizes to 3". Cast iron hook.
- I. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.
- J. Wall Support for Hot Pipe Sizes 6" and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
- K. Vertical Support: Steel riser clamp.
- L. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- M. Floor Support for Hot Pipe Sizes to 4": Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- N. Floor Support for Hot Pipe Sizes 6" and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- O. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

3.6 ADJUSTMENT OF HANGERS AND SUPPORTS:

- A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

END OF SECTION 232117

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SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Base mounted pumps.

1.2 RELATED SECTIONS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 21 14 - Hydronic Specialties.
- C. Section 23 0549 - Vibration Isolation for HVAC Piping and Equipment.
- D. Section 23 0513 - Common Motor Requirements.

1.3 REFERENCES

- A. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- B. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010).
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 778 - Standard for Motor-Operated Water Pumps; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- D. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements, for additional provisions.
 - 2. Extra Pump Seals: One set for each type and size of pump.

1.6 WARRANTIES:

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.
- B. Provide 1 year parts and labor warranty.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.
- B. Alignment: Base mounted pumps shall be aligned by qualified millwright.

1.8 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL 778 as suitable for the purpose specified and indicated.

1.9 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Provide one set of mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Armstrong Pumps Inc.
- B. ITT Bell & Gossett.
- C. Taco.

2.2 HVAC PUMPS - GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

2.3 BASE MOUNTED PUMPS

- A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.
- B. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.
- D. Bearings: Permanently lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Check, align, and certify alignment of base mounted pumps prior to start-up.
- H. Lubricate pumps before start-up.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Filter-driers.
- G. Flexible connections.

1.2 RELATED REQUIREMENTS

- A. Section 230719 - HVAC Piping Insulation.
- B. Section 230993 - Sequence of Operations for HVAC Controls.

1.3 REFERENCE STANDARDS

- A. AHRI 710 - Performance Rating of Liquid-Line Driers; Air-Conditioning, Heating, and Refrigeration Institute; 2009.
- B. AHRI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Driers; Air-Conditioning, Heating, and Refrigeration Institute; 2005.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE Std 15).
- D. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.
- E. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2013.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.

- G. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2010.
- H. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2011 (ANSI/ASME B31.9).
- I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.
- J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2013.
- K. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.
- L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- C. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
- D. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
 - 2. Use replaceable core liquid-line filter-driers in systems utilizing receivers.
- E. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of leak test, acid test.
- F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Filter-Dryer Cartridges: One of each type and size.
 - 2. Refrigeration Oil Test Kits: One, each containing everything required to conduct one test.

1.6 QUALITY ASSURANCE

- A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.

1.7 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- C. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn .

1. Fittings: ASME B16.22 wrought copper.
2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.

B. Pipe Supports and Anchors:

1. Provide hangers and supports that comply with MSS SP-58.
 - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
5. Vertical Support: Steel riser clamp.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
9. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density polypropylene.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
 - f. Manufacturers:
 - 1) PHP Systems/Design; PHP Pipe Supports: www.phpsd.com.

2.2 REFRIGERANT

A. Refrigerant: R-134a & R-410a as defined in ASHRAE Std 34.

2.3 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:

1. Henry Technologies: www.henrytech.com.
2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
3. Sporlan Valve Company: www.sporlan.com.

- B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.4 VALVES

A. Manufacturers:

1. Hansen Technologies Corporation: www.hantech.com.
2. Henry Technologies: www.henrytech.com.
3. Flomatic Valves: www.flomatic.com.

B. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.5 FILTER-DRIERS

A. Performance:

1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
3. Design Working Pressure: 350 psi, minimum.

- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.

1. Replaceable Core Type: Steel shell with removable cap.
2. Connections: As specified for applicable pipe type.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- F. Provide clearance for installation of insulation and access to valves and fittings.
- G. Flood piping system with nitrogen when brazing.
- H. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- I. Insulate piping; refer to Section and Section 23 07 16.
- J. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- K. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- L. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- M. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.
- B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.4 SCHEDULES

A. Hanger Spacing for Copper Tubing.

- 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
- 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
- 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
- 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.

END OF SECTION 232300

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SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning of piping systems.
- B. Chemical feeder equipment.
- C. Chemical treatment.

1.2 RELATED SECTIONS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 21 14 - Hydronic Specialties.

1.3 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- D. Certificate: Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.
- E. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
- F. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.6 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion. Include monthly service visits and all chemicals
- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- C. Provide laboratory and technical assistance services during this maintenance period.
- D. Include two-hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at startup of systems.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.7 MAINTENANCE MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Supply sufficient chemicals for treatment and testing during warranty and service period.
- C. Provide chemicals for additional 1-year from warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. ChemAqua

SCHRADERGROUP architecture LLC
Conshohocken, Pennsylvania
SGA Project: 23.029

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- B. Proasys
- C. ARC
- D. Guardian

2.2 MATERIALS

A. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite.

B. Closed System Treatment (Water):

1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.
4. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite.

2.3 BY-PASS (POT) FILTER/FEEDER

- A. 5.0 gallon with quick opening cap and 20 micron and 5 micron filter bags. Provide 20 of each type of filter bag for the Owner's use.

2.4 GLYCOL FEEDER

- A. Furnish and install a packaged, automatic glycol actuation make up unit model (GMU as manufactured by ITT Bell & Gossett or approved equal). The package shall consist of a base, polyethylene reservoir with removable lid, visible expansion tank, discharge pressure gage, motor contactor and control circuit in a NEMA 4 panel, and necessary interconnecting piping. Green light shall indicate power supplied to unit. Pump shall start based on falling pressure. System shall require a 115/1/60 single power connection and a 3/4" NPT system piping connection. GMU shall provide 5 GPM and maintain a fill pressure of 30 PSI. Unit includes low level cutout, with red indicator light and 110V contact for alarm indication, to stop the pump during low level condition.

2.5 TEST EQUIPMENT

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
- B. Provide the following test kits:
 - 1. Alkalinity titration test kit.
 - 2. Chloride titration test kit.
 - 3. Sulphite titration test kit.
 - 4. Total hardness titration test kit.
 - 5. Low phosphate test kit.
 - 6. Conductivity bridge, range 0 - 10,000 micro-ohms.
 - 7. Creosol red pH slide complete with reagent.
 - 8. Portable electronic conductivity meter.
 - 9. High nitrite test kit.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.

3.2 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by CLEANER manufacturer.
- B. Hot Water Heating Systems:
 - 1. Add cleaner, apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
 - 5. Test water sample to verify cleaner is removed.

C. Chilled Water Systems:

1. Add cleaner, circulate for 48 hours, then drain systems as quickly as possible.
 2. Refill with clean water, circulate for 24 hours, then drain.
 3. Refill with clean water and repeat until system cleaner is removed.
 4. Test water sample to verify cleaner is removed.
- D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.
- E. Flush open systems with clean water for one hour minimum. Drain completely and refill.
- F. Remove, clean, and replace strainer screens.
- G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- H. System shall flushed, treated, and tested in accordance with the phasing. Multiple phased treatments will be required.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

- A. Provide one bypass filter/feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens. Provide one for each bypass filter/feeder location.

3.5 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
1. Provide minimum of two hours of instruction for two people.
 2. Have operation and maintenance data prepared and available for review during training.

3. Conduct training using actual equipment after treated system has been put into full operation.

3.6 MAINTENANCE

- A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.
- B. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
- C. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- D. Provide laboratory and technical assistance services during this maintenance period.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION 232500

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Casing and plenums.
- C. Kitchen hood ductwork.
- D. Flexible Ductwork
- E. Duct cleaning.

1.2 RELATED REQUIREMENTS

- A. Section 230714 - Duct Insulation: External insulation and duct liner.
- B. Section 233300 - Air Duct Accessories.
- C. Section 233600 - Air Terminal Units.
- D. Section 233700 - Air Outlets and Inlets.
- E. Section 230593 - Testing, Adjusting, and Balancing for HVAC.

1.3 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.
- B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications; 2012.
- C. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2013.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
- E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2013.

- F. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy With Improved Formability, and Ultra-High Strength; 2013.
- G. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- H. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.
- J. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.
- K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- L. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2011.
- M. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.
- N. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.
- O. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication & Installation Guidelines; 2001.
- P. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for 1 inch pressure class and higher systems.
- D. Samples: Submit two samples of typical shop fabricated duct fittings.
- E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A standards.

1.7 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

- A. All Ducts: Galvanized steel, unless otherwise indicated.
- B. Low Pressure Supply (Heating Systems): 2 inch w.g. pressure class, galvanized steel.
- C. Low Pressure Supply (System with Cooling Coils): 2 inch w.g. pressure class, galvanized steel.
- D. Medium and High Pressure Supply: 4 inch w.g. pressure class, galvanized steel. Use for VAV systems between the unit and the VAV boxes.
- E. Outside Air Intake: 2 inch w.g. pressure class, galvanized steel.
- F. Combustion Air: CPVC.
- G. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, lined galvanized.
- H. Dishwasher Exhaust: 2 inch w.g. pressure class, stainless steel.
 - 1. Construct of 18 gage stainless steel using continuous external welded joints in rectangular sections.

- I. Grease Exhaust: 2 inch w.g. pressure class, stainless steel.
 - 1. Construction:
 - a. Construct of 18 gage stainless steel using continuous external welded joints in rectangular sections.
 - b. Where ducts are not self-draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
 - 2. Access Doors:
 - a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
 - b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- C. Stainless Steel for Ducts: ASTM A 240/A 240M, Type 304.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
 - 4. For Use With Flexible Ducts: UL labeled.
- E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- F. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

2.3 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- D. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.

2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with 18-gauge galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
 - 1. Manufacture in accordance with SMACNA HVAC Duct Construction Standards.
 - 2. Insulation:
 - a. Thickness: 1.5 inch
 - b. Material: Fiberglass.
- B. Double Wall Rectangular Ducts: Rectangular double wall ducts shall have a solid 18-gauge galvanized steel outer shell and a perforated inner liner, separated with a 1.5" thick fiberglass insulating layer. Fittings shall have solid inner walls.
- C. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
 - 1. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
 - 2. Maximum Velocity: 4000 fpm.
 - 3. Temperature Range: -20 degrees F to 210 degrees F.
 - 4. Minimum R-value: R-6
- D. PVC Coated Steel Ducts: UL 181, Class 1, galvanized steel duct coated with 4 mil (0.1 mm) polyvinyl chloride plastic on both sides.

2.5 KITCHEN HOOD EXHAUST DUCTWORK

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, SMACNA Kitchen Ventilation Systems and Food Service Equipment Fabrication & Installation Guidelines and NFPA 96 and the International Mechanical Code.

2.6 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- G. Use double nuts and lock washers on threaded rod supports.
- H. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- I. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- J. Exposed ductwork shall be furnished with a paint-grip finish.

3.2 DUCT LEAKAGE TESTING

- A. Perform duct leakage test in accordance with 230593 – HVAC Testing, Adjusting and Balancing. Perform all tests in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Perform leakage test for kitchen grease duct systems, 20% of medium and high-pressure duct systems and 10% of low-pressure duct systems. Leakage testing shall be conducted by the Contractor prior to system balancing.

3.3 CLEANING

- A. Ducts shall be installed per SMACNA cleanliness standards, shipped with sealed ends, and protected during construction and installation. Cleaning of new systems shall not be required if these steps are followed. If they are not followed, the HVAC system shall be cleaned using source removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select source removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification. Means, methods and materials shall be as described in the NADCA General Specifications for the Cleaning of Commercial HVAC Systems manual, and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.
- B. Exposed ductwork shall have its exterior cleaned (in accordance with the manufacturer's recommended methods) to the satisfaction of the Architect.
- C. All existing ductwork that is noted to remain (Gymnasium) shall be cleaned using source removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select source removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification. Means, methods and materials shall be as described in the NADCA General Specifications for the Cleaning of Commercial HVAC Systems manual, and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

END OF SECTION 233100

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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers.
- C. Duct access doors.
- D. Duct test holes.
- E. Fire dampers.
- F. Flexible duct connections.
- G. Volume control dampers.

1.2 RELATED SECTIONS

- A. Section 23 31 00 - HVAC Ducts and Casings.
- B. Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.

1.3 REFERENCES

- A. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- B. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- C. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- D. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- E. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers and duct access doors.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and smoke dampers..

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of access doors and test holes.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

1.8 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Provide two of each size and type of fusible link.

PART 2 - PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:
 - 1. Ruskin Company: www.ruskin.com.
 - 2. Titus: www.titus-hvac.com.

- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.2 BACKDRAFT DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc: www.louvers-dampers.com.
2. Nailor Industries Inc: www.nailor.com.
3. Ruskin Company: www.ruskin.com.

- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 DUCT ACCESS DOORS

A. Manufacturers:

1. Ruskin Company: www.ruskin.com.
2. Approved Equal.

- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.

1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.

- D. Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FIRE DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc: www.louvers-dampers.com.
2. Nailor Industries Inc: www.nailor.com.
3. Ruskin Company: www.ruskin.com.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling Dampers: Galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.

D. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

F. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

H. All dampers shall be dynamic type.

2.6 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

B. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - a. Net Fabric Width: Approximately 2 inches wide.
2. Metal: 3 inches wide, 24 gage thick galvanized steel.

2.7 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc: www.louvers-dampers.com.

2. Nailor Industries Inc: www.nailor.com.
 3. Ruskin Company: www.ruskin.com.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
- D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
- E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- G. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- H. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- I. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- J. Use splitter dampers only where indicated.
- K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- L. Provide turning vanes, Air Turning Devices, at all elbows greater than 45 degrees and all radiused elbows.
 - 1. Provide Blades: 2" galvanized steel for up to and including 18" ducts.
 - 2. Blades: 4 1/2" galvanized for ducts over 18"
 - 3. Construction: Double wall blade.
 - 4. Types: Gang operated blades with removable hex key.
 - 5. Types: Gang operated blades with removable lever.
 - 6. Types: Fixed blades for 90 degree elbows.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1- GENERAL

1.1 SECTION INCLUDES

- A. Roof exhausters.
- B. Ceiling-mounted fans.
- C. Kitchen hood exhausters.

1.2 RELATED SECTIONS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 33 00 - Air Duct Accessories.

1.3 REFERENCES

- A. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- C. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; <http://www.amca.org/certified/search/company.aspx>.
- D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.
- E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 1990.
- F. IMC 2018 - International Mechanical Code.
- G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2011.

- J. UL 705 - Power Ventilators; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- K. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fan Belts: One set for each belt-driven fan.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96 and the International Mechanical Code.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Permanent ventilators may not be used for ventilation during construction.

1.7 EXTRA MATERIALS

- A. Supply two sets of belts for each belt-driven fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Greenheck.
- B. Loren Cook Company.
- C. PennBarry.
- D. CaptiveAire.

2.2 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
- D. Fabrication: Conform to AMCA 99.
- E. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- G. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96 and the International Mechanical Code.

2.3 ROOF EXHAUSTERS

- A. Product Requirements:
 - 1. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
 - 3. Fabrication: Conform to AMCA 99.
 - 4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

- B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- C. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- D. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor .
- F. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
- G. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- H. Kitchen hood exhaust fans shall comply with NFPA 96 and shall have hinged plate and grease collection system.

2.4 KITCHEN HOOD EXHAUSTERS

A. Belt Drive Fan:

- 1. Fan Wheel:
 - a. Type: Non-overloading, backward inclined centrifugal.
 - b. Material: Aluminum.
- 2. Statically and dynamically balanced.
- 3. Motors:
 - a. Open drip-proof (ODP).
 - b. Heavy duty ball bearing type.
 - c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
 - d. Fully accessible for maintenance.
- 4. Housing:
 - a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
 - b. Rigid internal support structure.
 - c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
 - d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
 - e. Provide breather tube for fresh air motor cooling and wiring.

B. Shafts and Bearings:

1. Fan Shaft:
 - a. Ground and polished steel with anti-corrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.
2. Bearings:
 - a. Permanently sealed or pillow block type.
 - b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - c. 100 percent factory tested.

C. Drive Assembly:

1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

D. Disconnect Switches:

1. Factory mounted and wired.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
3. Finish for Painted Steel Enclosures: Provide manufacturer's standard unless otherwise indicated.
4. Positive electrical shutoff.
5. Wired from fan motor to junction box installed within motor compartment.

E. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

F. Accessories:

1. Birdscreen:
 - a. Provide galvanized steel construction.
 - b. Protects fan discharge.
2. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
3. Wall Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
4. Grease Trap:
 - a. Aluminum.
 - b. Includes drain connection.
 - c. Collects grease residue.

5. Hinge Kit:
 - a. Aluminum hinges.
 - b. Hinges and restraint cables mounted to base (sleeve).
 - c. Allows fan to tilt away for access to wheel and ductwork for inspection and cleaning.
6. Heat Baffle: Prevents heat from radiating into motor compartment.
7. Tie-down Points: Four brackets located on windband secures fan in heavy wind applications.

2.5 DIRECT DRIVE STANDARD CEILING MOUNTED CENTRIFUGAL EXHAUST FANS

A. General Description:

1. Base fan performance at standard conditions (density 0.075 Lb/ft³)
2. Ceiling mounted applications
3. Performance capabilities up to 52 cubic feet per minute (cfm) and static pressure to 0.625 inches of water gauge
4. Maximum operating temperatures is 130 Fahrenheit (54.4 Celsius)
5. Sound levels as low as 2.9 AMCA sones
6. UL/cUL listed for above bathtub exhaust
7. Fans are UL/cUL listed 507 - Electric Fans
8. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number

B. Wheel:

1. Forward curved centrifugal wheel
2. Constructed of high strength polymer
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.

C. Motors:

1. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets
2. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase
3. Accessible for maintenance
4. Compatible for use with speed controls
5. Thermal overload protection

D. Housing:

1. Constructed of heavy gauge galvanized steel
2. Profile as low as 3 5/8 inches

E. Plastic Backdraft Damper:

1. Prevents air from entering back into the building when fan is off

2. Eliminates rattling or unwanted backdrafts

F. Outlet:

1. Round outlet shall accept a three inch diameter duct
2. Plastic duct collar shall be a tapered sleeve for ease of connection

G. Grille:

1. Constructed of non-yellowing high strength polymer
2. Attached to the housing with torsion springs

H. Mounting Brackets:

1. Fully adjustable for multiple installation conditions

I. Accessories:

1. Provide disconnect switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counter-flash duct to roof opening.
- D. Provide sheaves required for final air balance.
- E. Install backdraft dampers on inlet to roof and wall exhausters, except kitchen hood fans.
- F. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.

END OF SECTION 233423

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SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable volume terminal units.
- B. Fan powered variable volume terminal units.
- C. Integral heating coils.

1.2 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 21 13 - Hydronic Piping: Connections to heating coils.
- C. Section 23 21 14 - Hydronic Specialties: Connections to heating coils.
- D. Section 23 31 00 - HVAC Ducts and Casings.
- E. Section 23 37 00 - Air Outlets and Inlets.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association; 2012.
- B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.

1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.
- D. Manufacturer's Installation Instructions: Indicate support and hanging details, and service clearances required.
- E. Project Record Documents: Record actual locations of units.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 MANUFACTURERS (**Addendum 05**)

- A. Johnson Controls Inc. (Basis of Design)
- B. Trane
- C. Daikin
- D. Carrier.**

2.2 MANUFACTURED UNITS

- A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electronic variable volume controls,, hot water heating coils.
- B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.3 SINGLE DUCT VARIABLE VOLUME UNITS

A. Basic Assembly:

- 1. Casings: Minimum 22 gage galvanized steel.
- 2. Lining: Minimum 1/2 inch thick neoprene or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with mylar film.
- 3. Plenum Air Inlets: Round stub connections for duct attachment.
- 4. Plenum Air Outlets: S slip and drive connections.

B. Basic Unit:

- 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
- 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.

C. Attenuator Section: Line attenuator sections with 2 inch thick insulation.

D. Hot Water Heating Coil:

- 1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
- 2. Provide insulation for exposed components of heating coil.

E. Automatic Damper Operator:

- 1. Electric Actuator: 24 volt with high limit.

F. Provide factory mounting and wiring of controls. Controls shall be provided by the ATC Contractor.

2.4 FAN POWERED VARIABLE VOLUME UNITS

A. Basic Assembly:

1. Casings: Minimum 22 gage galvanized steel.
2. Lining: Minimum 1 inch thick foil faced fiberglass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with mylar film.
3. Plenum Air Inlets: Round stub connections and S slip and drive connections for duct attachment.
4. Plenum Air Outlets: S slip and drive connections.

B. Basic Unit:

1. Configuration: Air volume damper assembly and fan in series arrangement inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.
3. Mount damper operator to position damper normally open.

C. Automatic Damper Operator:

1. Electric Actuator: 24 volt with remote temperature read and reset capability.

D. Fan Assembly:

1. Fan: Forward curved centrifugal type with direct drive EC motor.
2. Speed Control: Infinitely adjustable with electronic controls.
3. Isolation: Fan/motor assembly on rubber isolators.

E. Attenuator Section: Line attenuator sections with 2 inch thick insulation.

F. Hot Water Heating Coil:

1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.

G. Wiring:

1. Factory mount and wire controls provided by the ATC Contractor. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
2. Factory mount transformer for control voltage on electric and electronic control units. Provide terminal strip in control box for field wiring of thermostat and power source.
3. Wiring Terminations: Wire fan and controls to terminal strip. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
4. Disconnect Switch: Factory mount fused disconnect switch in control panel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Support units individually from structure. Do not support from adjacent ductwork.
- C. Connect to ductwork in accordance with Section 23 31 00.
- D. Verify that electric power is available and of the correct characteristics.

3.2 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow.

END OF SECTION 233600

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SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/grilles.
- C. Vents
- D. Roof hoods.

1.2 REFERENCES

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2012.
- B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute; 2008.
- C. ASHRAE Std 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; 2006.
- D. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

1.3 SUBMITTALS

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Titus
- B. Price Industries
- C. Metalaire
- D. Kreuger.

2.2 RECTANGULAR CEILING DIFFUSERS

- A. Type: Square and rectangular, multi-louvered diffuser to discharge air in pattern as indicated on the drawings.
- B. Frame: Lay-in mount type.
- C. Color: As shown on drawings.
- D. Fabrication: Steel with baked enamel finish.

2.3 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Color: As shown on the drawings.
- D. Fabrication: Steel with 20 gage minimum frames and 13 gauge minimum steel blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish, color to be selected.
- E. Fabrication: Steel with 20 gage minimum frames and 13 gauge minimum steel blades.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- G. Provide welded in place blades, securely fastened to be immobile.

2.4 CEILING SLOT DIFFUSERS

- A. Type: Continuous slots as scheduled on drawings with vanes for left, right , or vertical discharge.
- B. Color: As shown on the drawings.
- C. Fabrication: Aluminum extrusions with factory baked enamel finish .
- D. Frame: 1-1/4 inch margin with concealed mounting and gasket, mitered end border.
- E. Plenum: Integral, galvanized steel, insulated.

2.5 WALL SUPPLY REGISTERS/GRILLES

- A. Type: As scheduled on drawings.
- B. Color: As shown on the drawings.
- C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish, color to be selected.
- D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.
- E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.6 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
- B. Fabrication: Steel frames and blades, with factory baked enamel finish.
- C. Color: As shown on the drawings.
- D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.7 VENTS

- A. Dryer/Kiln Exhaust Termination: Provide Tjernlund Products, Inc. Model VH1-3 sidewall vent hood or equal.

2.8 ROOF HOODS

A. General Description:

- 1. Ventilator is low silhouette for intake/relief applications.

B. Hood and Base:

- 1. Material Type: Aluminum.
- 2. Hood Constructed of precision formed, arched panels with interlocking seams.
- 3. Vertical end panels are fully locked into hood end panels.
- 4. Base height is standard of 5 inches.
- 5. Curb cap is six inches larger than throat size.
- 6. Curb cap has pre-punched mounting holes for installation.

C. Birdscreen:

- 1. Constructed of ½ inch Aluminum mesh.
- 2. Mounted horizontally across the intake area of the hood.

D. Hood Support:

- 1. Constructed of galvanized steel and fastened so the hood can either be removed completely from the base or hinged open.

E. Options/Accessories:

- 1. Roof Curbs:
 - a. Type: Welded, straight sided curb.
 - b. Material: Aluminum.
 - c. Insulation thickness: 2 inches.
 - d. Height: 18 inches.
- 2. Dampers:
 - a. Type: As noted on the drawings.
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with pre-punched mounting holes
- 3. Insect Screen:
 - a. Constructed of fine mesh aluminum
 - b. Fitted to the top of the throat and prevents entry of insects

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location and sizes of outlets and inlets and make necessary adjustments in position and/or size to conform with architectural features, symmetry, lighting arrangement, and ceiling grid.
- C. Ceiling grilles and registers shall fit in tiles without infringing on the ceiling grid. Any discrepancies shall be reported prior to ordering the inlet/outlet.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 90 00.

END OF SECTION 233700

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SECTION 233750 – WALL LOUVERS

PART 1 GENERAL

1.1 SUMMARY

- A. This section includes fixed, extruded-aluminum louvers.
- B. Related Sections include the following:
 - 1. Division 07 Section “Joint Sealants”: Sealants installed in perimeter joints between louver frames and adjoining construction.

1.2 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.3 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg. F., ambient; 180 deg. F., material surfaces.
- B. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer’s sock units identical to those provided, except for length and width according to AMCA 500-L.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.
- C. Samples for Verification: For each type of metal finish required.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain louvers through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, “Structural Welding Code—Aluminum”.
- C. SMACNA Standard: Comply with recommendations in SMACNA’s “Architectural Sheet Metal Manual” for fabrication, construction details, and installation procedures.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurement on Shop Drawings. Coordinate the requirements of the recessed flange installation with G.C.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Greenheck; Model ESD-603.
2. Pottorf; Model EFD-637.
3. Ruskin Company; Model ELF6375DX.

2.2 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 1. Use types and sizes to suit unit installation conditions.
 2. Use Phillips flat-head screws for exposed fasteners, unless otherwise indicated.
- D. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads for imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

- A. Assemble louvers in factory in minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide subsills made of same material as louvers.
- F. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.4 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:

1. Louver Depth: 6 inches.
2. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.80 inch.
3. Louver Blades: 45 degree slope with center baffle, return bend, and continuous blade reinforcing.
4. Mullion Type: Concealed structural mullions.
5. Free Area: Not less than 8.0 sq.ft. for 48-inch-wide by 48-inch high louver.
6. Frame construction shall contain integral flanges, to be mounted within brick courses. Coordinate the requirements with the G.C. prior to ordering.

2.5 LOUVER SCREENS

A. General: Provide screen at interior face of each exterior louver.

1. Screening Type: Bird screening for louvers connected to ducts; insect screening for louvers not connected to ducts.

B. Secure screens to louver frames with stainless-steel machine screws, spaces a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type for Bird Screening: Non-rewireable frame with a driven spline or insert for securing screen mesh.
4. Type for Insect Screening: Rewirable frame with a driven spline or insert for securing screen mesh.

D. Louver Screening:

1. Bird Screening: Aluminum, ½-inch-square mesh, 0.063-inch wire.
2. Insect Screening: Stainless steel, 18-by-18 mesh, 0.009-inch wire.

2.6 BLANK-OFF PANELS

A. Insulated Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets.

1. Thickness: 2 inches unless otherwise indicated.

2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
3. Insulating Core: Unfaced mineral-fiber or foamed-plastic rigid insulation board.
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with 1/8-by-1-inch PVC compression gaskets.
6. Panel Finish: Same type of finish applied to louvers, but black color.
7. Attach blank-off panels of louver frames with clips or stainless-steel, sheet metal screws.

2.7 ALUMINUM FINISH

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designating finishes.
- B. Finish louvers after assembly.
- C. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
- D. High-Performance Organic-Coating Finish: AA-C12C42R1 x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 1. Fluoropolymer Two-Coat Coating system: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 2. Color: Custom color to match Architect's sample.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitting joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes to no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed surfaces of louvers that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surface and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 233750

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SECTION 234000 – HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disposable panel filters.

1.2 RELATED SECTIONS

- A. Division 1 - Temporary Facilities and Controls: Filters for temporary heating and ventilating.
- B. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Division 1 – Summary of the Project.

1.3 REFERENCES

- A. ARI 850 - Commercial and Industrial Air Filter Equipment; Air-Conditioning and Refrigeration Institute; 2004.
- B. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 1992.
- C. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.; 2004.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to ARI 850 Section 7.4.
 - 1. Dust Spot Efficiency: Plus or minus 5 percent.

1.5 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

- D. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.
- E. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

1.6 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Provide two sets of disposable filters for each piece of HVAC equipment requiring air filters.

PART 2 PRODUCTS

2.1 FILTER MANUFACTURERS

- A. American Filtration Inc: www.americanfiltration.com.
- B. Camfil Farr Company: www.camfilfarr.com.

2.2 DISPOSABLE PANEL FILTERS

- A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
 - 1. Nominal Size: 24 x 24 inches (610 x 610 mm).
 - 2. Thickness: 1 inch (25 mm).
- B. Performance Rating:
 - 1. Face Velocity: 500 FPM (2.54 m/sec).
 - 2. Initial Resistance: 0.15 inch WG (37 Pa).
 - 3. Recommended Final Resistance: 0.50 inches WG (125 Pa).
- C. Casing: Cardboard frame.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION 234000

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SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manufactured breechings.
- B. Manufactured double wall chimneys for fuel fired equipment.

1.2 RELATED SECTIONS

- A. Section 23 0716 - HVAC Equipment Insulation.

1.3 REFERENCES

- A. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.
- B. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; National Fire Protection Association; 2010.
- C. UL 441 - Standard for Gas Vents; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 DEFINITIONS

- A. Breeching: Vent Connector.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- D. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.5 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

- C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations .
- D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.
- E. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.
- F. Manufacturer shall provide pressure drop calculations for each stack run and verify with heating equipment manufacturer stack pressure drop is within manufacturer's recommended limits.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of documented experience and approved by manufacturer.

1.7 REGULATORY REQUIREMENTS

- A. Conform to applicable code for installation of natural gas burning appliances and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Metal-Fab, Inc.
- B. Heat Fab.

2.2 MANUFACTURED BREECHINGS

- A. Assembly to be UL listed for use with building equipment in compliance with NFPA 211.
- B. Fabricate with 1 inch minimum air space between walls and construct inner liner of AL-49C stainless steel and outer jacket of 304 stainless steel.
- C. Design, fabricate, and install gas-tight preventing products of combustion leaking into the building.

1. Securely connect inner joints and seal with factory supplied overlapping V-bands and appropriate sealant in accordance with manufacturer's instructions.
2. System design to compensate for all flue gas induced thermal expansion.

2.3 DOUBLE WALL METAL STACKS

- A. Provide double wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.
- B. Fabricate with 1 inch minimum air space between walls and construct inner liner of AL29-4C stainless steel and outer jacket of 304 stainless steel.
 1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
- C. Accessories, UL labeled:
 1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
 2. Exit Cone: Consists of inner cone, and outer jacket, to increase stack exit velocity 1.5 times.
 3. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.
- D. Provide pressure rated double wall metal stacks, tested to UL 103 and UL listed, for use with boilers and domestic hot water heaters, in compliance with NFPA 211.
- E. For gas fired condensing boilers and domestic hot water heaters provide positive pressure AL 29-4C vent. Refer to drawing details for locations of single and double wall vent and installation requirements.
- F. Manufacturers:
 1. Heat Fab: Model Saf-T Vent SC.
 2. Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54.
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

- D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards for equivalent duct support configuration and size.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Level and plumb chimney and stacks.
- G. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

3.2 SCHEDULES

A. Breechings, Chimneys and Stacks

- 1. Boilers: Double wall pressure stack type AL 29-4C.

END OF SECTION 235100

SECTION 235233 - HIGH EFFICIENCY CONDENSING BOILERS (ALTERNATE 4) (Addendum 02)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Boilers.**
- B. Boiler trim.**
- C. Hot water connections.**
- D. Fuel connection.**

1.2 REFERENCES

- A. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2004 (addendum 2005).**
- B. ASME (BPV IV) - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2004.**
- C. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2004.**
- D. HI BTS - Testing and Rating Standard for Commercial Boilers; The Hydronics Institute; 2000.**
- E. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2006.**
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.**
- G. UL (HCVCE) - Heating, Cooling, Ventilating and Cooking Equipment Directory; Underwriters Laboratories Inc.; current edition.**

1.3 PERFORMANCE REQUIREMENTS

- A. Performance rating shall be in accordance with Hydronics Institute Testing and Rating Standard for Commercial Boilers.**
- B. Scheduled performance shall comply with ARI 210/240 test conditions.**

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittals procedures.**
- B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements.**
- C. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.**
- D. Manufacturer's Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.**
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.**
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.**

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.**

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable code for internal wiring of factory wired equipment.**
- B. Conform to ASME (BPV IV) and (BPV VIII,1) for boiler construction.**
- C. Units: AGA certified.**
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.**

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.**

1.8 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.**
- B. The pressure vessel/heat exchanger of the boiler shall have a ten-year warranty against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship. The circuit boards of the control panel assembly shall have a two-year warranty against failure due to defective materials or workmanship. The boiler shall have a complete warranty for all components and systems for a one-year period. The one-year warranty period shall begin when the building has been determined to be substantially complete. The one and two-year warranties shall include parts and labor. A warranty certificate must be issued to the Owner from the manufacturer and a copy of the warranty must be submitted for engineer's approval.**

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Advanced Thermal Hydronics model KN-30 (Alternate 4).**
- B. The Contractor's price for the Alternate must include the cost difference between the basis of design concrete pad (indicated on the plans) and these boilers. The KN-30 boilers are physically larger than the basis of design and the pad must accommodate this difference.**

2.2 REGULATORY REQUIREMENTS

- A. Boiler shall be; UL Listed, CSD-1 approved, ASME coded and stamped, and incorporate a gas train designed in accordance with IRI.**
- B. The boiler manufacturer must publish known part load value efficiencies; the thermal efficiency must increase as the firing rate decreases. The accuracy of these published efficiencies must be reviewed & confirmed by Underwriter's Laboratories, Inc.**
- C. Boiler control panel shall incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display, on individual field replaceable circuit boards mounted within a single housing.**
- D. Boiler shall have an ASME approved relief valve setting of 50 psig.**

- E. The contractor shall bear the responsibility of, and conform to the requirements of Pennsylvania’s Labor and Industry Department’s “Boilers and Unfired Pressure Vessels” regulations. This includes, but is not limited to, submitting the “Intent to Install Boiler” form and coordinating all subsequent inspection visits.**

2.3.1 CONSTRUCTION

- A. Design: Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 5:1 continuous turn down with constant CO2 over the turndown range. The boiler shall operate with natural gas and have a CSA International certified input rating as noted on the drawings, and a thermal efficiency rating up to 99% at minimum input. The boiler shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The boiler will automatically adjust input for altitude and temperature induced changes in air density. The boiler shall use a proven pilot interrupted spark ignition system. The boiler shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The UV detector shall be air cooled to prevent condensate formation and so designed as to prevent misalignment. The design shall provide for silent burner ignition and operation. The boiler shall be down fired counter flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. A stainless steel corrosion resistant condensate drain designed to prevent pooling and an accessible condensate trap shall be provided. In some jurisdictions, a means of neutralizing the condensate Ph levels may be required. Boiler shall be able to vent a horizontal distance of 80 equivalent feet with a vent diameter equivalent to the combustion chamber outlet diameter.**
- B. Service Access: The boilers shall be provided with access covers for easily accessing all serviceable components. The boilers shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All accesses must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.**
- C. Indicating lights: Each boiler shall include a diagnostic control panel with a full text display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.**
- D. Combustion Chamber: The combustion chamber shall be constructed of cast-iron. It shall be a down-fired design utilizing lightweight refractory around the burner housing.**
- E. Heat Exchanger: Boilers shall be a cast iron sectional unit designed for pressure firing and shall be constructed and tested for 100 P.S.I water working pressure, in accordance with the A.S.M.E. Section IV Rules for the Construction of Heating Boilers. Individual sections will have been subjected to a hydrostatic pressure test of 250 PSIG at the factory before shipment and they shall be marked, stamped or cast with the A.S.M.E. Code symbol. Boilers with less than 250-psi pressure**

test will not be acceptable for this project. The sections shall be of a down fired counter flow single-pass design. Water ports will be sealed with graphite port connectors. The sections will be fully machined for metal to metal sealing of the gas side surfaces. The design will provide for equal temperature rise through all sections. The heat exchanger shall be designed to prevent fluid boiling. The iron shall have a minimum thickness of 1/4". The heat exchanger design should have no limitations on temperature rise or restrictions to inlet water temperature.

F. Jackets: Stainless Steel.

G. Boiler Controls:

1. The boiler control system shall be segregated into three components: Control Panel, Power Box, and Input/Output Connection Box. The entire system shall be Underwriters Laboratories Recognized.
2. The control panel shall consist of 6 individual circuit boards utilizing state-of-the-art surface-mount technology, in a single enclosure. These circuit boards shall be defined as follows: display board incorporating LED display to read temperature, and a VFD display module for all message annunciation; CPU board which houses all control functions; electric low water cutoff board with test and manual reset functions; power supply board; ignition/stepper board incorporating flame safeguard control; and connector board. Each board shall be individually field replaceable. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor. The control panel hardware shall support both RS-232 and RS-485 remote communications. The controls shall annunciate boiler & sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of 8 separate status messages and 34 separate fault messages.
3. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features are called: Set point High Limit, Set point Low Limit, and Failsafe Mode. Set point High Limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor.
4. Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler without header temperature swings.
5. The boiler manufacturer shall supply as part of the boiler package a completely integrated boiler management system to control all operation and energy input of the multiple boiler heating plant. The boiler management system shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the boilers via the RS-485 port. The system controller shall have the ability to operate up to 32 boilers per panel.
6. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire plant. The controller shall be a PID type controller and use a control algorithm for

accurate temperature control with variable load response. The controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

7. When set on internal set point mode, the temperature control set point on the system shall be fully field adjustable from 50F to 190F in operation.
8. When set on indoor/outdoor reset mode, the system will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation.
9. When set on 4mA to 20 mA temperature control mode, the system will operate the plant to vary header temperature set point linearly as an externally applied 4-20 mA signal is supplied.
10. When set on MODBUS temperature control mode, the system will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol, supplied via the RS-232 port.
11. The system controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard.
12. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts.
13. Connection between the system and individual boilers shall be twisted pair low voltage wires.
14. Boiler control valves (BCV), and the boiler control valve panel shall be provided by the boiler manufacturer. Interconnecting wiring shall be provided by the contractor. Refer to drawings for BCV Panel location.

H. Controls Interoperability

1. The control panel and the boiler management system shall utilize the MODBUS open protocol to interface with the third party BAS.
2. Controls interface with BACnet, Lonworks and N2 shall utilize a communications gateway to act as a MODBUS interface/translator between the BAS and either the RS-485 port of the control panel or the RS-232 port of the boiler management system. The gateway shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the boilers via the RS-485. Gateway shall be provided by boiler manufacturer. Contractor shall coordinate interface (BACnet or Lonworks) with BAS Subcontractor prior to ordering the boiler.
3. Non-volatile backup of all point mappings and programs shall be internally provided as standard.
4. Connection between the gateway and individual boilers or to the boiler management system shall be daisy chained, with shielded, twisted pair, low voltage wiring.

I. Installation

- 1. All aspects of installation of Boiler Plant shall be in strict accordance with manufacturer's instructions. The vent system must conform to all manufacturer's recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure.**
- 2. Boiler shall have individually isolating shutoff valves for service and maintenance.**

J. Field Services

- 1. Contractor shall provide the services of a local factory authorized representative to supervise all phases of equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the engineer with operation and maintenance instructions.**

2.4 FUEL BURNING EQUIPMENT-CONDENSING:

- A. The burner shall be metal fiber mesh construction, allowing high turndown of the fuel-air mixture. The burner flame shall burn horizontally and be of the pre-mix type with a forced draft fan. Burner shall fire to provide equal distribution of heat throughout the entire heat exchanger. The burner shall be easily removed for maintenance without the disruption of any other major component of the boiler. A window view port shall be provided for visual inspection of the boiler during firing. The gas distribution components and burner shall be enclosed with cast-aluminum housing.**
- B. Ignition components: The ignition hardware shall consist of Alumina ceramic insulated ignition electrodes and UV sensing tube permanently arranged to ensure proper ignition electrode and UV alignment.**
- C. Rated Capacity: The boiler shall be capable of operating at rated capacity with pressures as low as 4.0 at the inlet to the burner pressure regulator. Maximum gas pressure shall not exceed 14.0 " w.c.**
- D. The burner shall be capable of 99% efficiency without exceeding a Nox reading above 11ppm.**
- E. The burner and gas train shall be provided with the following trim and features:**
 - 1. Burner Firing: Full modulation with 5:1 turndown @ Continuous CO2**
 - 2. Burner Ignition: Interrupted spark**
 - 3. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.**

4. **Flue-Gas Collector:** Enclosed combustion chamber with integral combustion-air blower and single venting connection.
5. **Gas Train:** Manual gas valves (2), main gas valve (solenoid), manual test and check valves, pilot gas pressure regulator, and automatic pilot gas valve. All components to be factory mounted and CSD-1 compliant.
6. **Safety Devices:** Low gas pressure switch, air-flow switch, and blocked flue detection switch, low water cutoff (manual reset), high temperature manual reset. All safeties to be factory mounted.
7. **Individual gas regulator** provided by factory, shipped loose for field installation, one per boiler

PART 3 EXECUTION

3.1 INSTALLATION

- A. **Install in accordance with manufacturer's instructions.**
- B. **Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.**
- C. **Install boiler on concrete housekeeping base, sized minimum 4 inches (100 mm) larger than boiler base.**
- D. **Provide piping connections and accessories as indicated; refer to Section 23 2114.**
- E. **Pipe relief valves to nearest floor drain.**

3.2 START UP

- A. **The manufacturer shall submit to the Owner, a fully completed start-up and field test report for each boiler. The test report shall include boiler efficiency and combustion checks, safety device checks, gas train inspection and testing, and flue gas analysis.**
- B. **The contractors and manufacturer shall perform and document pre-functional checks of the boiler system control panel, sensors, aquastats, make-up water devices, lead/lag operation, and hot water temperature control.**
- C. **The manufacturer shall support the testing by providing prompt on-site and factory support with troubleshooting, modifications, spare parts, and performance data as needed from the team during the functional testing.**

- D. The boiler manufacturer shall provide up to eight (8) hours of Operation and Maintenance training to the Owner. The training syllabus and materials shall be submitted to the Owner for review and approval prior to actual training.**

END OF SECTION 235233

SECTION 235233 - HIGH EFFICIENCY CONDENSING BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Boilers.
- B. Boiler trim.
- C. Hot water connections.
- D. Fuel connection.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Aerco International Benchmark Series Boiler.
- B. RBI Flexcore CK Series Boiler.
- C. Raypak Xvers Boiler.

2.2 REGULATORY REQUIREMENTS

- A. Boiler shall be; UL Listed, CSD-1 approved, ASME coded and stamped, and incorporate a gas train designed in accordance with IRI.
- B. The boiler manufacturer must publish known part load value efficiencies; the thermal efficiency must increase as the firing rate decreases. The accuracy of these published efficiencies must be reviewed & confirmed by Underwriter's Laboratories, Inc.
- C. Boiler control panel shall incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display, on individual field replaceable circuit boards mounted within a single housing.
- D. Boiler shall have an ASME approved relief valve setting of 50 psig.

2.3 CONSTRUCTION

- A. Boiler modules shall be natural gas fired, condensing fire tube design with a modulating forced draft power burner and positive pressure vent discharge.

B. Modulating Air/Fuel Valve and Burner:

1. The boiler burner shall be capable of a 15 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves.
2. The burner shall produce <30ppm of NOx corrected to 3% excess oxygen.
3. The burner shall be metal fiber mesh covering a stainless steel body, with spark ignition and flame rectification.
4. All burner material exposed to the combustion zone shall be of stainless steel construction.
5. There shall be no moving parts within the burner itself.
6. A modulating air/fuel valve shall meter the air and natural gas input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A cast aluminum venturi with integral mixer shall be utilized to ensure the optimum pre-mix of air & fuel between the air/fuel valve and the burner,

C. Pressure Vessel/Heat Exchanger:

1. The boiler shall be capable of handling return water temperatures down to 40 F without any failure due to thermal shock or fireside condensation. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig.
2. The pressure vessel shall have a maximum water volume of 49 gallons. The boiler water pressure drop shall not exceed 5.5 psig at 258gpm.
3. The boiler water connections shall be 4" flanged 150 lb. ANSI rated. The pressure vessel is constructed of SA53 carbon steel, with a 0.25" thick wall and 0.25 in. thick upper head.
4. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code.
5. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.
6. The heat exchanger shall be constructed of 316L stainless steel fire tubes and tube sheets with a one-pass combustion gas flow design.
7. The fire tubes shall be 5/8" OD with no less than 0.065" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.313" thick.
8. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig.
9. Access to the tubesheets and heat exchanger is available by burner and exhaust manifold removal. Minimum access opening shall be no less than 10 in. diameter.

D. Exhaust Manifold:

1. The exhaust manifold shall be of corrosion resistant cast aluminum with an 8" diameter flue connection. The exhaust manifold shall have a gravity drain for the elimination of the condensation with collecting reservoir.

E. Boiler Controls:

1. The boiler control system shall be segregated into three components: Control Panel, Power Box, and Input/Output Connection Box. The entire system shall be Underwriters Laboratories Recognized.
2. The control panel shall consist of 6 individual circuit boards utilizing state-of-the-art surface-mount technology, in a single enclosure. These circuit boards shall be defined as follows: display board incorporating LED display to read temperature, and a VFD display module for all message annunciation; CPU board which houses all control functions; electric low water cutoff board with test and manual reset functions; power supply board; ignition /stepper board incorporating flame safeguard control; and connector board. Each board shall be individually field replaceable. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor. The control panel hardware shall support both RS-232 and RS-485 remote communications. The controls shall annunciate boiler & sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of 8 separate status messages and 34 separate fault messages.
3. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features are called: Setpoint High Limit, Setpoint Low Limit, and Failsafe Mode. Setpoint High Limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor.

F. Network Direct Drive:

1. Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler without header temperature swings.
2. The boiler will operate to vary the boiler firing rate as an external communication utilizing the MODBUS protocol is supplied via the RS-485 port. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. The boiler shall have LCD display for monitoring of all sensors and interlocks.

G. Controls Interoperability

1. The control panel shall utilize the MODBUS or Lon Works open protocol to interface with third party building automation systems. When the Building Automation System (BAS) does not have MODBUS protocol capability and interoperability is required, the manufacturer shall provide a protonode to act as a Gateway interface between the BAS and the boiler control panel.

H. Installation

1. All aspects of installation of Boiler Plant shall be in strict accordance with manufacturer's instructions. The vent system must conform to all manufacturer's recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure.
2. Boiler shall have individually isolating shutoff valves for service and maintenance.

I. Warranty

1. The pressure vessel/heat exchanger of the boiler shall carry a non-prorated 7 year warranty against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship. A Warranty Certificate must be issued to the owner from the manufacturer and a copy of warranty must be submitted for engineer's approval.

J. Field Services

1. Contractor shall provide the services of a local factory authorized representative to supervise all phases of equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the engineer with operation and maintenance instructions.

END OF SECTION 235233

SECTION 236400 – AIR COOLED CHILLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Design, performance criteria, refrigerants, controls, and installation requirements for air-cooled scroll compressor chillers.

1.2 RELATED REQUIREMENTS

- A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment.
- C. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- D. Section 23 0923 - Automatic Temperature Controls.
- E. Section 23 0992 - HVAC Control Sequence.
- F. Section 23 2113 - Hydronic Piping.
- G. Section 23 2114 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

- A. AHRI 550/590 - Standard for Performance Rating of Water-Chilling Packages Using the Vapor Compression Cycle; Air-Conditioning, Heating, and Refrigeration Institute; 2011.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc; 2010 (ANSI/ASHRAE Std 15).
- C. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc; 2010, Including All Addenda, (ANSI/ASHRAE/IESNA Std 90).
- D. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2013.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- F. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

- G. UL 1995 - Heating and Cooling Equipment; Underwriters Laboratories Inc; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

1.5 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- D. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.
- E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements, for additional provisions.
 - 2. Extra Refrigerant: One container.
 - 3. Extra Lubricating Oil: One container.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Conform to manufacturer's written installation instructions for rigging, unloading, and transporting units.
- B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.8 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: The manufacturer shall provide a warranty for two years, covering all portions of the units. Defective parts shall be repaired or replaced during the warranty period at no charge to the Owner. The warranty period shall commence at the project's substantial completion. The compressors and heat exchange circuit shall be warranted for five years. The warranties shall include parts and labor.

PART 2 PRODUCTS

2.1 MANUFACTURERS (**Addendum 05**)

- A. JCI (Basis of Design).
- B. Trane.
- C. Daikin.
- D. **Carrier.**

2.2 AIR COOLED CHILLER

A. UNIT DESCRIPTION

- 1. Provide and install as shown on the plans factory-assembled, factory-charged air-cooled scroll compressor packaged chillers in the quantity specified. Each chiller shall consist of hermetic tandem scroll compressor sets (total four compressors), brazed plate evaporator, air-cooled condenser section, microprocessor-based control system and all components necessary for controlled unit operation.
- 2. Chiller shall be functionally tested at the factory to ensure trouble free field operation

B. DESIGN REQUIREMENTS

1. Flow Range: The chiller shall have the ability to support variable flow range down to 40% of nominal design (based on AHRI conditions).
2. Operating Range: The chiller shall have the ability to control leaving chilled fluid temperature from 15F to 65F.
3. General: Provide a complete scroll compressor packaged chiller as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.02 and any local codes in effect.
4. Performance: Refer to the schedule of performance on the drawings. The chiller shall be capable of stable operation to a minimum percentage of full load (without hot gas bypass) of 17%. Performance shall be in accordance with AHRI Standard 550/590.
5. Acoustics: Sound pressure levels for the unit shall not exceed the following specified levels. All manufacturers shall provide the necessary sound treatment (parts and labor) to meet these levels if required. Sound data shall be provided with the quotation. Test shall be in accordance with AHRI Standard 370.

C. CHILLER COMPONENTS

1. Compressor
 - a. The compressors shall be sealed hermetic, scroll type with crankcase oil heater and suction strainer. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads. The compressors shall be equipped with an internal module providing compressor protection and communication capability.
2. Evaporator
 - a. The evaporator shall be a compact, high efficiency, dual circuit, brazed plate-to-plate type heat exchanger consisting of parallel stainless steel plates.
 - b. The evaporator shall be protected with an external, electric resistance heater plate and insulated with 3/4" (19mm) thick closed-cell polyurethane insulation. This combination shall provide freeze protection down to -20°F (-29°C) ambient air temperature.
 - c. The water-side working pressure shall be a minimum of 653 psig (4502 kPa). Evaporators shall be designed and constructed according to, and listed by Underwriters Laboratories (UL).
3. Condenser
 - a. Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct-drive fan motors. The fans shall be equipped with a heavy-gauge vinyl-coated fan guard. Fan motors shall be TEAO type with permanently lubricated ball bearings, inherent overload protection, three-phase, direct-drive, 1140 rpm. Each fan section shall be partitioned to avoid cross circulation.
 - b. Coil shall be microchannel design and shall have a series of flat tubes containing multiple, parallel flow microchannels layered between the refrigerant manifolds. Tubes shall be 9153 aluminum alloy. Tubes made of 3102 alloy or other alloys of lower corrosion resistance shall not be accepted. Coils shall consist of a two-pass arrangement. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils

shall withstand 1000+ hour acidified synthetic sea water fog (SWAAT) test (ASTM G85-02) at 120°F (49°C) with 0% fin loss and develop no leaks.

4. Refrigerant Circuit
 - a. Each of the two refrigerant circuits shall include a replaceable-core refrigerant filter-drier, sight glass with moisture indicator, liquid line solenoid valve (no exceptions), expansion valve, and insulated suction line.
5. Construction
 - a. Unit casing and all structural members and rails shall be fabricated of pre-painted or galvanized steel. Painted parts shall be able to meet ASTM B117, 1000-hour salt spray test.
 - b. Upper condenser coil section of unit shall have protective, 12 GA, PVC-coated, wire grille guards.
6. Control System
 - a. A centrally located weatherproof control panel shall contain the field power connection points, control interlock terminals, and control system. Box shall be designed in accordance with NEMA 3R rating. Power and starting components shall include factory circuit breaker for fan motors and control circuit, individual contactors for each fan motor, solid-state compressor three-phase motor overload protection, inherent fan motor overload protection and two power blocks (one per circuit) for connection to remote, contractor supplied disconnect switches. Hinged access doors shall be lockable. Barrier panels or separate enclosures are required to protect against accidental contact with line voltage when accessing the control system.
 - b. Shall include optional multi-point disconnect switches (one per circuit).
7. Unit Controller
 - a. An advanced DDC microprocessor unit controller with a 5-line by 22-character liquid crystal display provides the operating and protection functions. The controller shall take preemptive limiting action in case of high discharge pressure or low evaporator pressure. The controller shall contain the following features as a minimum:
 - b. The unit shall be protected in two ways: (1) by alarms that shut the unit down and require manual reset to restore unit operation and (2) by limit alarms that reduce unit operation in response to some out-of-limit condition. Shut down alarms shall activate an alarm signal.
 - c. Shutdown Alarms
 - 1) No evaporator water flow (auto-restart)
 - 2) Sensor failures
 - 3) Low evaporator pressure
 - 4) Evaporator freeze protection
 - 5) High condenser pressure
 - 6) Outside ambient temperature (auto-restart)
 - 7) Motor protection system
 - 8) Phase voltage protection (Optional)
 - d. Limit Alarms
 - 1) Condenser pressure stage down, unloads unit at high discharge pressures.
 - 2) Low ambient lockout, shuts off unit at low ambient temperatures.

- 3) Low evaporator pressure hold, holds stage #1 until pressure rises.
- 4) Low evaporator pressure unload, shuts off one compressor.
- e. Unit Enable Section
 - 1) Enables unit operation from either local keypad, digital input, or BAS
- f. Unit Mode Selection
 - 1) Selects standard cooling, ice, glycol, or test operation mode
- g. Analog Inputs:
 - 1) Reset of leaving water temperature, 4-20 mA\
 - 2) Current Limit
- h. Digital Inputs
 - 1) Unit off switch
 - 2) Remote start/stop
 - 3) Flow switch
 - 4) Ice mode switch, converts operation and set-points for ice production
 - 5) Motor protection
- i. Digital Outputs
 - 1) Shutdown alarm; field wired, activates on an alarm condition, off when alarm is cleared
 - 2) Evaporator pump; field wired, starts pump when unit is set to start
- j. Condenser fan control - The unit controller shall provide control of condenser fans based on compressor discharge pressure.
- k. Building Automation System (BAS) Interface
 - 1) Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARK ® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
 - 2) BACnet MS/TP master (Clause 9)
 - 3) BACnet IP, (Annex J)
 - 4) BACnet ISO 8802-3, (Ethernet)
 - 5) LONMARK FTT-10A. The unit controller shall be LONMARK® certified.
 - 6) The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
 - 7) For chillers communicating over a LONMARK network, the corresponding LONMARK eXternal Interface File (XIF) shall be provided with the chiller submittal data.
 - 8) All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

D. ACCESSORIES

1. The following accessories shall be included:
 - a. Hot Gas Bypass: allows unit operation to 10 percent of full load. Includes factory-mounted hot gas bypass valve, solenoid valve, and manual shutoff valve for each circuit.
 - b. Low Ambient Control: Fan VFD allows unit operation from 32°F down to -10°F (-23.3 C).
 - c. High Ambient Control Panel for operation from 105°F up to 125°F ambient temperatures
 - d. Phase loss with under/over voltage protection and with LED indication of the fault type to guard against compressor motor burnout.
 - e. BAS interface module to provide interface with the BACnet MSTP protocol.
 - f. Compressor Sound Reduction - Acoustic reduction blankets shall be factory installed on each compressor.
 - g. Spring vibration isolators for field installation
 - h. Factory-mounted thermal dispersion type flow switch
 - i. Field-mounted, paddle type, chilled water flow switch field wired to the control panel
 - j. Wye strainer, to be installed at the evaporator inlet and sized for the design flow rate , with perforation diameter of 0.063" with blowdown valve and Victaulic couplings (factory mounted or field installed)
 - k. 115V GFI convenience outlet

E. ACOUSTICAL TREATMENTS

1. The following accessories shall be included:
 - a. Acoustical Hushcore blankets for compressors and piping shall be furnished by BRD and installed by this Contractor. Approved equals shall be pre-approved by the engineer.
 - b. Acoustical Hushcore Premium OF curtains for a 75' long portion of the new enclosure shall be furnished by BRD and installed by this Contractor. Coordinate length and height with dimensions represented on civil plans. Approved equals shall be pre-approved by the engineer.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in strict accordance with manufacturer's requirements, shop drawings, and contract documents.
- B. Adjust and level chiller in alignment on supports.
- C. Coordinate electrical installation with electrical contractor.
- D. Coordinate controls with control contractor.

- E. Install a field-supplied or optional manufacturer-supplied strainer in the chilled water return line at the evaporator inlet that meets manufacturer perforation size specifications.
- 3.2 START-UP
- A. Provide testing and starting of machine, and instruct the Owner in its proper operation and maintenance.

END OF SECTION 236426

SECTION 237313 – AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rooftop Air Handling Units
- B. Rooftop Energy Recovery Units
- C. Indoor Air Handling Units

1.2 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment.
- B. Section 230549 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- C. Section 230719 - HVAC Piping Insulation.
- D. Section 233300 - Air Duct Accessories: Flexible duct connections.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).
- C. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment; 2011.
- D. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; Air-Conditioning, Heating, and Refrigeration Institute; 2001 (R2011).
- E. AHRI 430 - Standard for Central-Station Air-Handling Units; Air-Conditioning, Heating, and Refrigeration Institute; 2009.
- F. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 2010.
- G. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- H. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.

- I. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc; 2007.
- J. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2012.
- K. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2012.
- L. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2012.
- M. ASHRAE Std 62.1 - Ventilation For Acceptable Indoor Air Quality; 2012.
- N. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2010, Including All Addenda (ANSI/ASHRAE/IESNA Std 90).
- O. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating; 2011.
- P. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- Q. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- R. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2012.
- S. SMACNA (DCS) - HVAC Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- T. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; current edition.
- U. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data:

- 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
- 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
- 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
- 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.

5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- D. Manufacturer's Instructions: Include installation instructions.
- E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Division 1 - Product Requirements, for additional provisions.
 2. Extra Fan Belts: One set for each unit.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 MANUFACTURERS (**Addendum 05**)

- A. Johnson Controls Inc. (Basis of Design)

- B. Trane.
- C. Daikin.
- D. Valent.
- E. Carrier.**

2.2 GENERAL DESCRIPTION

- A. Configuration: Fabricate as detailed on drawings.
- B. Performance: Conform to AHRI 430. See schedules on prints. (NOTE: above does not apply to fan array)
- C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

2.4 UNIT CONSTRUCTION

- A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
- B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
 - 1. The inner liner shall be constructed of G90 galvanized steel.
 - 2. The outer panel shall be constructed of G60 painted galvanized steel.
 - 3. The floor plate shall be constructed as specified for the inner liner.
 - 4. Unit will be furnished with solid inner liners.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
- D. The casing leakage rate shall not exceed .5 cfm per square foot of cabinet area at 5 inches of positive static pressure or 6 inches of negative static pressure (.0025 m³/s per square meter of cabinet area at 1.24 kPa static pressure).

- E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
- F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- G. The unit base shall be provided by this manufacturer.
- H. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2" thickness of insulation under drain pan.
- I. Rooftop units shall have exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- J. Rooftop units shall have a unit base that overhangs the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.
- K. An insulated pipe chase shall be provided and the unit's roof curb shall extend to house the pipe chase. The Roofcap over vestibule shall be a continuous single piece covering both the coil section and the vestibule. Roofcap seams between coil section and vestibule are not allowed.

2.5 FAN ASSEMBLIES

- A. Provide ECM, motorized impeller fan(s). Fan assembly shall include fan, fan base, and a motor and shall be dynamically balanced by the fan manufacturer.
 - 1. Motor control panel shall come equipped with a fused disconnect.
 - 2. Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault.
 - 3. Motor shall be brushless DC type with a permanent magnet rotor.

4. Fan section shall come equipped with a motor control panel mounted on the fan section. Both line voltage and low voltage wiring shall be done by the factory. Each fan shall have an isolation switch.
5. Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.

2.6 BEARINGS, SHAFTS & DRIVES

- A. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be designed for service with an L-50 life of 200,000 hours and shall be a heavy duty pillow block, self-aligning, grease-lubricated ball or spherical roller bearing type.
- B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

2.7 ELECTRICAL

- A. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPart requirements), 1750 RPM, single speed, 200V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
- B. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
- C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
- D. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
- E. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.

2.8 COOLING AND HEATING COILS

- A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification

programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.

- B. Water heating and cooling coils shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
 2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
 3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
 4. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
 5. Coil shall be furnished as an uncased galvanized steel track to allow for thermal movement and slide into a pitched track for fluid drainage.

2.9 FILTERS

- A. Furnish flat filter in mixing box section with 2-inch pleated MERV 13 filter with microbial resistant Intersept coating. Provide side loading and removal of filters.
- B. Filter media shall be UL 900 listed, Class I or Class II.
- C. Filter Magnehelic gauge(s) shall be furnished and mounted by equipment manufacturer.

2.10 HEAT EXCHANGER – ENTHALPY WHEEL

- A. The device shall be an aluminum substrate with 4 angstrom molecular sieve desiccant.
- B. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.
- C. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
- D. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.
- E. Energy recovery wheel media shall be constructed of fluted aluminum with permanently-bonded zeolite desiccant.
- F. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.
- G. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.
- H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
- I. Rotor media shall be reinforced using aluminum structural spokes with extruded central hub and shaft and shall be connected to shaft using pillow bearings.
- J. Energy wheel cassette shall include seals, drive motor, and linked drive belt.
- K. Latent energy shall be transferred entirely in the vapor phase with no condensation.
- L. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories Recognized Component for electrical and fire safety.
- M. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.

2.11 ADDITIONAL SECTIONS

- A. Face and bypass section shall be provided to modulate airflow through and around heat transfer coils. Dampers shall be an integral part of the unit assembly. Internal face and

top bypass shall be contained in the standard cabinet height. Blank-off and division sheets, internal linkage, access installed by unit manufacturer. Face and bypass dampers shall be of low leak design, opposed blade, with vinyl bulb edging and stainless steel edge seals, galvanized steel frame and axles in self-lubricating nylon bearings.

- B. Mixing box section shall be provided with top outside air opening and end return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

2.12 CONTROLS

- A. ATC devices shall be provided and field mounted by the BAS Manufacturer. The contractor shall coordinate these requirements.
- B. Combination Starter-Disconnects:
 - 1. Provide combination starter-disconnect for each fan motor.
 - 2. Factory mount in full metal enclosure and wire to fan motor.
 - 3. Mount starter-disconnect on fan section externally in a NEMA 1 enclosure within a dedicated controls section or housed fan section.
 - 4. Include circuit breaker disconnect with through-the-door interlocking handle for externally mounted starters, spring loaded, and designed to rest only in the full and lockable ON or OFF state.
 - 5. Allow enclosure entry via a concealed defeater mechanism when the handle is in the ON position.
 - 6. Include the following items:
 - a. Hand-Off-Auto (H-O-A) switch.
 - b. Two normally open auxiliary contacts.
 - c. Overload heaters.
 - d. 120V control transformer with fusing and secondary grounding.
 - 7. Include power wiring from the starter control transformer to the secondary control system transformers, and start-stop wiring from the direct digital controller start-stop relay to the starter H-O-A switch.
- C. Combination VFD - Disconnects:
 - 1. Provide factory mounted, combination VFD - disconnect in accordance with Section 26 29 23 for each fan motor.
 - 2. Factory mount in full metal enclosure and wire to fan motor.

3. Mount VFD-disconnect on fan section externally in a NEMA 1 enclosure within a dedicated controls section or housed fan section.
 - a. Internal Enclosure Construction Characteristics:
 - 1) Integral part of unit casing to allow for thermal venting to casing interior.
 - 2) Accessible from unit exterior via access door.
 - 3) Construction of access doors same throughout unit.
4. Include circuit breaker disconnect with through-the-door interlocking handle for externally mounted starters, spring loaded, and designed to rest only in the full and lockable ON or OFF state.
5. Include control transformer with sufficient capacity to support the following items:
 - a. VFD and controls.
 - b. Binary output on-off wiring.
 - c. Analog output speed-signal wiring.
 - d. All interfacing wiring between the VFD and the direct digital controller.
6. Provide bypass relays and bypass circuitry with VFD-OFF-BYPASS selector switch.

2.13 ROOF CURBS.

- A. Vibration isolation roof curbs shall be provided by the rooftop unit manufacturer. Refer to section 23 05 49 to clarify requirements.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Bolt sections together with gaskets.
- C. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- D. Provide sheaves required for final air balance.
- E. Hydronic Coils:
 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 3. Locate water supply at bottom of supply header and return water connection at top.
 4. Provide manual air vents at high points complete with stop valve.
 5. Ensure water coils are drainable and provide drain connection at low points.

F. Insulate coil headers located outside air flow as specified for piping. Refer to Section 23 07 19.

G. Field-wire all factory provided controls for field installation.

END OF SECTION 237313

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SECTION 238101 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Convectors.
- B. Unit heaters.
- C. Cabinet unit heaters.
- D. Fan coil units.

1.2 RELATED SECTIONS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment.
- B. Section 230993 - Sequence of Operations for HVAC Controls.

1.3 SUBMITTALS

- A. Product Data: Provide typical catalog of information including arrangements.
- B. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 3. Indicate mechanical and electrical service locations and requirements.,
- C. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- D. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- E. Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.

1.6 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.

PART 2 - PRODUCTS

2.1 CONVECTORS

- A. Manufacturers:
 - 1. Sterling Hydronics.
 - 2. Rittling.
 - 3. Modine.
- B. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and cast iron headers, steel side plates and supports, factory air pressure tested at 100 psi under water, with means of adjusting pitch of element.
- C. Cabinet: 0.0598 inch steel front and top, 0.0478 inch steel back and ends; exposed corners rounded; easily secured removable front panels, adequately braced and reinforced for stiffness.
- D. Finish: Factory applied baked enamel of color as selected.
- E. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
- F. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 x 7 inch minimum size, integral with cabinet.

2.2 UNIT HEATERS

- A. Manufacturers:

1. Sterling Hydronics.
 2. Rittling.
 3. Modine.
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Casing: 0.0478 inch steel with threaded pipe connections for hanger rods.
- D. Finish: Factory applied baked primer coat.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- F. Air Outlet: Adjustable pattern diffuser on projection models and two way louvers on horizontal throw models.
- G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.
- H. Control: Local disconnect switch.
- I. Capacity: As scheduled, based on 65 degree F entering air temperature, 180 degree F average water temperature.

2.3 CABINET UNIT HEATERS

- A. Manufacturers:
1. Sterling Hydronics.
 2. Rittling.
 3. Modine.
- B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 220 degrees F.
- C. Cabinet: 0.0598 inch steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet.
- D. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.
- E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.

G. Control: Multiple speed switch, factory wired, located in cabinet.

H. Filter: Easily removed 1 inch thick permanent washable type, located to filter air before coil.

2.4 FAN-COIL UNITS

A. Manufacturers:

1. Daikin.
2. Carrier.
3. Johnson Controls Inc.

B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 200 psi (1380 kPa) and 220 degrees F. (104 degrees C.). Provide drain pan under cooling coil, easily removable for cleaning, with drain connection.

C. Cabinet: 0.0598 inch (1.5 mm) steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet.

D. Finish: Factory apply baked primer coat on visible surface of enclosure or cabinet.

E. Fans: Supply fans shall be a DWDI forward-curved type. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.

F. Motor: An ECM blower motor shall be provided on all units. Factory motor wiring shall be set for optimum fan performance. The unit shall be shipped at one fixed setting. The ECM motor shall utilize a permanent magnet rotor, which is connected to the shaft through resilient rings to absorb high frequency torque ripple. ECM motor shall be programmed for constant CFM or constant torque.

G. Control: Multiple speed switch, factory wired, located in cabinet.

H. Filter: Easily removed 1 inch (25 mm) thick glass fiber throw-away type, located to filter air before coil.

I. Capacity: As Scheduled, based on 65 degrees F. (18 degrees C) entering air temperature, 180 degree F (82 degree C) average water temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

- B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Do not damage equipment or finishes.
- C. Protection: Provide finished cabinet units with protective covers during balance of construction.
- D. Convectors: Install where indicated. Coordinate to assure correct recess size for recessed convectors.
- E. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- F. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.

3.2 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION 238101

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SECTION 238127 - SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air cooled condensing units.
- B. Indoor ductless fan & coil units.
- C. Controls.

1.2 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
- D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE Std 15).
- E. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- G. UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

- D. Design Data: Indicate refrigerant pipe sizing.
- E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- F. Project Record Documents: Record actual locations of components and connections.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Filters: One for each unit.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.5 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer's warranty for compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS (**Addendum 05**)

- A. Daikin.
- B. Mitsubishi.
- C. EMI.
- D. Carrier.**

2.2 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.

1. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

2.3 INDOOR UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

1. Construction and Ratings: In accordance with AHRI 210/240 and UL listed.

2.4 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 1. Comply with AHRI 210.
 2. Refrigerant: R-410A.
 3. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL listed.
- B. Compressor: AHRI 520; hermetic, two speed 1800 and 3600 rpm, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
 1. Provide thermostatic expansion valves.
- D. Operating Controls:
 1. Control by room thermostat to maintain room temperature setting.
 2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to 0 degrees F.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A.
- C. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION 238127

SECTION 238313 - RADIANT-HEATING CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Heating cable.
- B. Temperature controllers for heating cable.

1.2 RELATED SECTIONS

- A. Section 232113 - Hydronic Piping
- B. Section 230719 - HVAC Piping Insulation.
- C. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Division 1 – Summary of the Project.

1.3 PERFORMANCE REQUIREMENTS

- A. Pipe Trace Heating: Freeze protection with outside temperature at -10 degrees F (-23 degrees C).

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for heating cable and control components.
- C. Shop Drawings: Indicate heating cable layout, locations of terminations, thermostats, and branch circuit connections.
- D. Manufacturer's Installation Instructions: Indicate installation instructions.
- E. Project Record Documents: Accurately record actual locations of heating cable and branch circuit connections.
- F. Operation Data: Include description of operating controls.
- G. Maintenance Data: Include repair methods and parts list of components.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 PRE-INSTALLATION MEETING

- A. Convene one week prior to commencing work of this section.
- B. Require attendance of parties directly affecting the work of this section.
- C. Review sequencing of installation, protection from damage of finished installation, location of expansion and control joints in building, and methods used for covering installations with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Chromalox; Model SRL
- B. Orbit
- C. Nexans

2.2 HEATING CABLE

- A. Heating Cable: Self-limiting, parallel resistance heating cable.

2.3 ACCESSORIES

- A. Thermostats:
 - 1. Chromalox
 - 2. Orbit
 - 3. Nexans

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping is ready to receive work.

- B. Verify field measurements are as shown on shop drawings.
- C. Verify that required utilities are available, in proper location, and ready for use.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Avoid pinching and making sharp bends in cable.
- C. Do not install heating cable across expansion or construction joints.
- D. E.C. shall provide a service to the proximity of the cable locations. H.C. shall provide junction box and all interconnecting wiring between the E.C. service and the cables. H.C. shall be responsible for the final connection to the E.C. service.

3.3 FIELD QUALITY CONTROL

- A. Test continuity of heating cable.
- B. Perform tests on completed cable installation. For cables embedded in concrete, perform tests immediately before and after concrete placement.
- C. Measure voltage and current at each unit.

3.4 DEMONSTRATION

- A. Demonstrate operation of heating cable controls.

END OF SECTION 238313

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SECTION 260100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General Conditions and Division-1 Specifications sections, apply to work specified in this section.

1.2 SCOPE OF PROJECT:

- A. Provide a complete and operating electrical installation in accordance with these specifications and accompanying contract drawings. This includes all required labor, materials, apparatus and supervision.
- B. Without limiting or restricting the volume of work and solely for the convenience of the Contractor, the work to be performed in general, comprises the following:
 - 1. Temporary lighting.
 - 2. Temporary power to construction trailers and building construction power.
 - 3. Upgraded electrical service.
 - 4. Complete lighting and automatic lighting control systems.
 - 5. Complete building power system.
 - 6. Flash-arc labeling.
 - 7. Final connections to all equipment, unless otherwise noted.
 - 8. New outdoor gas-fired emergency system with a new automatic transfer switch, including all new devices associated with the connections to the portable generator.
 - 9. New PA system.
 - 10. New addressable fire alarm and detection system throughout the building.
 - 11. New LED theatrical lighting system and sound-reinforcement system for the cafeteria.
 - 12. New sound-reinforcement systems for the gymnasium and music classroom.
 - 13. Control wiring for Division 23 equipment where shown on Division 26 documents.
 - 14. New Structured Cabling System.
 - 15. Training of all new and systems.
 - 16. New access control system.
 - 17. Fire-proofing where required per code.
 - 18. Coordination with other contractors.

1.3 INTENT OF THIS SECTION:

- A. This Section is intended as a supplement to each of the following Sections of Division 26, 27, 28 and 31 ELECTRICAL.

- B. Consider each article of this Section as a part of each of the following Sections insofar as such requirements may be termed applicable.

1.4 TRUE INTENT:

- A. The Drawings and Specifications are intended to provide a complete and perfectly operating system. Therefore, it is specifically agreed and understood by the Contractor that anything, be it labor, material or equipment, which is not described in the Specifications or specifically shown on the Drawings, but is necessary for the operation and completion of a perfectly operating system, according to the true intent of the Specifications and Drawings and as interpreted by the architect, shall be furnished by the Contractor as a part of his Contract, at no extra charge, as though it were specifically detailed and described.

1.5 DEFINITIONS:

- A. General - Basic Contract definitions are included in the Conditions of the Contract.
- B. Indicated - The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.
- C. Directed - Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.
- D. Approved - The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications and requests, is limited to the Architects duties and responsibilities as stated in the Conditions of the Contract.
- E. Regulation - The term regulation includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation and similar operations.
- G. Install - The tem install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. Provide - The term provide means to furnish and install, complete and ready for the intended use.

- I. Contractor - The Contractor or Electrical Contractor - The term means the Contractor responsible for all work under this section.
- J. Installer - An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - 1. The term experienced, when used with the term installer, means having a minimum of five previous projects similar in size and scope to this project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
 - 2. Trades - Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
 - 3. Assigning Specialists - Certain Section of the Specifications require that specific construction activities are performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
 - a. This requirement is not to be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- K. Testing Agencies - A testing agency is an independent entity engaged to perform specific inspections or tests, both at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.6 VISITS TO SITE:

- A. Attention is directed to the necessity for all the Electrical Contractor to visit the site and examine all conditions affecting the proper execution of this Contract. Submission of proposals shall be considered evidence that Contractors have visited and examined the site.
- B. Existing contours and topography as indicated, are believed to be reasonably correct, but are not guaranteed. Where conditions at project site do not agree exactly with conditions as indicated, Contractor shall assume all responsibility for said discrepancy.
- C. No extra payment will be allowed the Electrical Contractor for extra work caused by failure to visit, examine and clarify.

1.7 GENERAL:

- A. Throughout the Specifications, types of material are specified by manufacturer's name. Where more than one manufacturer is mentioned, catalog and specification data is given for a specific manufacturer. Equal material produced by other manufacturers listed is acceptable. Refer to PRODUCT REQUIREMENTS - Division 1 for substitution of materials.

1.8 RULES AND REGULATIONS

- A. Perform in accordance with the rules and regulations of the National Electric Code (NEC), International Building Code (IBC) and other Codes and Standards cited in this specification and the requirements of the Utility Companies serving this project.
- B. Certificates of Approval in triplicate, for rough and finished wiring from a Certified Inspection Service must be delivered to the Engineer before final payment can be authorized.
- C. Perform all work in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration) and any other national, state, or local authority having jurisdiction.
- D. Perform all Construction, design, fabrication, tests, rating, and installation in compliance with the regulations of all local, state or national agencies having jurisdiction over the project. Pay all costs involved in work necessary to comply with these regulations.
- E. The Contractor assumes all responsibility and liability for any code violations, damage or injury which occurs as a result of deviation from or a change to the requirements of these plans and specifications which has not been approved in writing by the Engineer.

1.9 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW:

- A. Submit Shop Drawings in accordance with SUBMITTALS Division 1 and as indicated in subsequent Sections of this Division. Assume responsibility for quantities and correct mounting details. In addition, submit other shop drawings as may be requested by the Architect. Provide the following shop drawings including, but not limited to:
 - 1. Overcurrent Coordination Study
 - 2. Arc Flash Study.
 - 3. Metal Clad Cable
 - 4. Building Wire
 - 5. Conduit
 - 6. Fittings
 - 7. Wireways
 - 8. Outlet Boxes
 - 9. Floor Boxes
 - 10. Switches

11. Receptacles
12. Wall Plates
13. Occupancy Sensors & Automatic Lighting Controls
14. Dimmer Switches
15. Switchboard Breakers
17. Panelboards
18. Safety Switches and fuses
19. Circuit Breakers
20. Lighting Fixtures including lamp and ballast or driver information
21. Theatrical Lighting equipment
22. Fire Alarm & Detection System Equipment
23. Emergency Generator and associated equipment
24. Automatic Transfer Switches
25. PA and Master Clock Equipment
26. Structured Cable System Equipment
27. Sound Reinforcement System Equipment

1.10 DRAWINGS:

- A. The Electrical drawings are indicative of the general arrangements and approximate sizes and relative locations of principal materials to be provided. Drawings are diagrammatic and are a graphic representation of contract requirements to best available standards at the scale required. Provide certain items such as pull boxes, offsets to clear interferences, and supports which are not specifically shown but which are obviously needed to make the system complete and operable.
- B. Verify all grades, elevations, dimensions and clearances at the site.
- C. Electrical riser and schematic diagrams generally indicate wiring to be used in various systems. Provide all work shown on diagrams whether or not it is duplicated on the plans.
- D. All drawings and specifications pertaining to general construction, plumbing, HVAC, kitchen, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to coordinate with other trades, this Contractor shall rearrange his work at his own experience.

1.11 ENVIRONMENTAL CONDITIONS:

- A. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions or temperature in area or moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.

1.12 PROTECTION:

- A. Provide effective protection against damage for all materials and equipment during shipment, and storage at the Project site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.
- B. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.
- C. Protect all rough and finished floors and finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor coverings. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

1.13 PRODUCT:

- A. Have materials delivered to site. Unload and store materials in allotted location, and protect from damage. Deliver materials to their point of installation.
- B. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

1.14 COMPLIANCE WITH GENERAL STANDARDS AND REGULATIONS:

- A. Provide equipment that is in conformity with these specifications and applicable requirements of the following:
 - 1. AASHTO American Assoc. of State Highway and Transportation Officials
 - 2. ACI American Concrete Institute
 - 3. AISC American Institute of Steel Construction
 - 4. AISI American Iron and Steel Institute
 - 5. ANSI American National Standards Institute
 - 6. ASTM American Society for Testing and Materials
 - 7. AWS American Welding Society
 - 8. CBM Certified Ballast Manufacturers Assoc.
 - 9. CRSI Concrete Reinforcing Steel Institute
 - 10. EIA Electronic Industries Assoc.
 - 11. ETL ETL Testing Laboratories Inc.
 - 12. FM Factory Mutual Research Assoc.
 - 13. ICEA Insulated Cable Engineers Association, Inc.
 - 14. IEC International Electrotechnical Commission
 - 15. IEEE Institute of Electrical and Electronic Engineers

- | | | |
|-----|-------|---|
| 16. | IESNA | Illuminating Engineering Society of North America |
| 17. | IMSA | International Municipal Signal Association |
| 18. | LPI | Lighting Protection Institute |
| 19. | NEC | National Electric Code |
| 20. | NECA | National Electrical Contractors Association |
| 21. | NEMA | National Electrical Manufacturers Association |
| 22. | NETA | International Electrical Testing Association |
| 23. | NFPA | National Fire Protection Association |
| 24. | UL | Underwriters Laboratories, Inc |

1.15 COMPLIANCE WITH FEDERAL GOVERNMENT AGENCIES

- A. Names and titles of federal government standard - or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard - Specification-producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to the date of the Contract Documents.

- | | | |
|----|------|---|
| 1. | ADA | Americans with Disabilities Act |
| 2. | CFR | Code of Federal Regulations |
| 3. | EPA | Environmental Protection Agency |
| 4. | FAA | Federal Aviation Administration (US Dept. of Transportation) |
| 5. | FCC | Federal Communication Commission |
| 6. | FS | Federal Specification (from GSA); Specifications Unit (WFISIS) |
| 7. | MIL | Military Standardization Documents (US Department of Defense) Naval Publications and Forms Center |
| 8. | OSHA | Occupational Safety and Health Administration (US Department of Labor) |
| 9. | REA | Rural Electrification Administration (US Department of Agriculture) |

1.16 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year from date of Final Payment. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

PART 2 - PRODUCTS

- 2.1 Refer to Division 26 – ELECTRICAL, Division 27 – COMMUNICATIONS, Division 28 - ELECTRONIC SAFETY AND SECURITY and Division 31 – EARTHWORK.

PART 3 - EXECUTION

3.1 LOCATION OF MATERIAL:

- A. Locate all lighting fixtures, power apparatus, conduit, outlets and other materials to result in proper operation of the building and to avoid conflicts with the work of other trades. Obtain required location information sufficiently in advance of installation time to allow uninterrupted progress of the work. Check layouts of equipment with shop drawings of all trades to determine roughing-in requirements. Do not scale drawings for exact locations. Exercise proper judgment to secure a neat arrangement of conduit, piping, ductwork and other material; and to overcome local interferences to best advantage of the Project.
- B. Where physical interferences cannot be resolved readily, consult with the Engineer and Architect and prepare dated, dimensioned drawings correcting the interferences. Obtain written approval of the Engineer and Architect for such changes and distribute the drawings to all interested parties as directed by the Engineer and Architect.
- C. In modular panel ceilings, locate lights, detectors and similar equipment as shown on reflected ceiling plan. Arrange ceiling outlets symmetrically.
- D. Locate switches and other manually operated devices in a location easily accessible and convenient to operating personnel. If any such devices are mounted in a location deemed inaccessible or impractical, relocate devices at no increase in contract costs.

3.2 EARTHWORK:

- A. Provide all excavation, backfill, shoring and similar work as required for the installation of the Work of this Division. Refer to the requirements of Excavation and Division 31.
- B. Protect roots of live trees encountered in excavation.
- C. Where excavations at footings, foundations, and other structures are deeper than the angle of repose deemed adequate by Architect, backfill such excavations solidly with 3000 pound concrete.
- D. Remove and dispose of excess excavated materials as directed by the Engineer or Architect.

3.3 FLASHING AND COUNTERFLASHING:

- A. The Roofing Contractor shall provide metal flashing and counterflashing for Division 27 and 28 installations in accordance with SHEET METAL, Division 7, for all conduits penetrating the roof. Form counterflashing into a rainhood attached to conduit and passed down over top of flashing. Attach counterflashing to conduit with clamp, and waterproof with sealing compound.
- B. Base flashing will be worked into roofing.

3.4 CHASES AND OPENINGS:

- A. Openings, recesses and chases will be provided in the building construction as described in GENERAL CONDITIONS. Make detailed dimensioned drawings under Division 27 and 28 where required by Architect.

3.5 CUTTING AND PATCHING:

- A. The EC shall perform all cutting of existing building construction under Division 26, 27 and 28 as required for installation of electrical work.
- B. The EC shall perform cutting carefully so as not to damage the structure or leave unsightly surfaces that cannot be covered with plates, escutcheons, or other normal concealing construction.
- C. The GC shall be responsible for the repair of all adjacent construction and finishes that are visible and are damaged during the installation of electrical devices and extension of such work. The EC shall repair all construction that is not visible but requires repair to maintain construction integrity.
- D. Refer to 260538 Firestopping for additional requirements.

3.6 CONCRETE:

- A. Provide all concrete required for the work of Division 31 - EARTHWORK, unless otherwise noted. Provide 3000 pound concrete in accordance with the provisions of Division- CONCRETE.
- B. The GC shall provide concrete equipment pads for all freestanding electrical equipment inside the building, unless otherwise noted.

3.7 MOTOR STARTERS

- A. Furnish all manual motor starters, and mount where shown on drawings.

- B. Mount manual motor starters for roof fans in an accessible location inside the building to avoid affecting thermal devices by atmospheric conditions.
- C. In general, magnetic motor starters will be delivered to the site by the HC with the equipment they control.
 - 1. Starters furnished under Division 21, 22, and 23 will be delivered to the Electrical Contractor for installation and wiring. The Electrical Contractor shall mount the starters where shown on the Drawings, and provide power wiring to the starter, as well as power wiring from the starter to the motor. Control wiring will be provided under the HVAC Contract.
 - 2. Equipment furnished under other Divisions and under other contracts generally will not be combination type. Provide disconnects as required by the NEC within site of the controller and motor.
 - 3. Check running current of each motor and verify correct size of overload elements, and fuses in combination starters. Notify Architect in writing of all overload elements and fuses incorrectly sized, so that corrective action can be initiated.
 - 4. Prepare a typewritten list of all motors in the project, and submit to Architect for delivery to the Owner. Include the following information for each motor:
 - a. Function and nomenclature, as identified by the marking actually used in the field.
 - b. Physical location in the building.
 - c. Rated horsepower, voltage and phase.
 - d. Rated full load current.
 - e. Proper size of thermal overload element.
 - f. Mount all motor starters, except those factory mounted on equipment.

3.8 COLOR CODING OF WIRING

- A. Color code all wiring in accordance with the following table. In general, use factory colored insulation. Use colored vinyl tape for black insulation on cables No. 8 and larger. Apply pressure sensitive tape in half-lap serving for distance of 6" at cable terminations, in pull boxes, manholes, panels, and similar locations.

1.	<u>Phase</u>	<u>208/120 Volts</u>
2.	Phase "A"	Black
3.	Phase "B"	Blue
4.	Phase "C"	Red
5.	Neutral	White
6.	Equipment ground	Green

3.9 PHASING

- A. Phase building load centers and panelboards "A", "B", "C" top to bottom and left to right. Identify the neutral, although it may be in different locations for different equipment.
- B. Connect transformers in all systems so that:
 - 1. "A" Phase is terminated at "H1" connection.
 - 2. "B" Phase is terminated at "H2" connection.
 - 3. "C" Phase is terminated at "H3" connection.
 - 4. "X1" connection shall be the "A" Phase.
 - 5. "X2" connection shall be the "B" Phase.
 - 6. "X3" connection shall be the "C" Phase.
- C. Ascertain from Power Company phase identifications at the point of connection and thereafter carry out and maintain this consistent system of color coding, phase identification and positioning.
- D. Verify phase rotation after all terminations at equipment have been made, by producing a 1-2-3 rotation on a phase sequence meter when connected to "A", "B", and "C" phases. Make phase rotation compatible with existing distribution system.

3.10 GROUNDING RESISTANCE TEST:

- A. Provide grounding system resistance test to verify resistance. Maximum resistance shall be 5 ohms.
- B. Send final certified test reports and Certifications to Engineer for approval and transmittal to the Owner in accordance with SUBMITTALS, Division 1.

3.11 INSPECTION AND CERTIFICATION:

- A. Obtain and deliver a final Certificate of Approval from the applicable NEC inspection authority having jurisdiction. Make delivery to Engineer for transmittal to the Owner upon completion of the work and before final payment in accordance with PROJECT CLOSE-OUT, Division 1. Pay all charges made by the inspection authority and include their cost in the bid. Also, the contractor shall initiate the inspection made by the Township Building Code Official. The Owner shall pay for the Township inspection.

3.12 INSTALLATION:

- A. Install equipment in accordance with manufacturer's recommendations.

3.13 EQUIPMENT BY OWNER:

- A. The Owner will furnish certain equipment, and deliver this equipment to the site as stated in EQUIPMENT FURNISHED BY OWNER, Division 11. Provide final electrical connections as required.

3.14 AS-BUILT DRAWINGS:

- A. During construction, the Contractor shall maintain a record set of installation prints. He shall record on these prints all deviations from the Contract Drawings in conduit sizing, location, and details. The record set of installation prints shall be updated at the end of each month and shall be reviewed by the Engineer and the Owner.
- B. At the completion of the work, the Contractor shall forward these prints to the Engineer and the Architect for incorporation into the final As-Built Drawings.

3.15 UTILITY CONTACTS:

- A. PECO (electric) –
- B. Verizon –
- C. Sunesys –
- E. Comcast -

3.16 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.
- B. Three copies of factory maintenance schedules shall be furnished for each of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.
- D. Instructions described shall be given for the following systems:
 - 1. Fire Alarm & Detection System.
 - 2. PA & Master Clock System.
 - 3. Theatrical Lighting and Sound System.

4. Lighting control systems.

END OF SECTION 260100

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SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.

1.2 RELATED REQUIREMENTS

- A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.

- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 72 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
- F. Existing Low-Voltage Systems: Maintain existing systems in service until new system is complete and ready for service. Disable systems only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 72 hours before partially or completely disabling systems.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 - 2. PCB- and DEHP-containing lighting ballasts.
 - 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

- A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION 260505

SECTION 260513 – MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Medium voltage cable.
- B. Cable terminations.

1.2 RELATED REQUIREMENTS

- A. Section 337119 - Electrical Underground Ducts and Manholes: Cable racks in manholes.
- B. Section 260553 - Identification for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. IEEE 48 - IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV; Institute of Electrical and Electronic Engineers; 1996 (R2009).
- B. NEMA WC 70 - Non-Shielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009.
- C. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 013300 – Submittal Procedures, for submittal procedures.
- B. Product Data: Provide for cable, terminations, and accessories.
- C. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual sizes and locations of cables.
- F. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.
- G. Maintenance Data: Include instructions for testing and cleaning cable and accessories.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- C. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles of Project.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- E. Cable must meet all PECO requirements for use as service entrance conductors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Southwire Company: www.southwire.com
- B. Prysmian Corp.
- C. The Okonite Company.
- D. Substitutions: See Section 016000 - Product Requirements.

2.2 CABLE

- A. Medium Voltage Cable (Incoming PECO service entrance): PECO Approved Cable.

1. Voltage: 35kV grounded. 133%
2. Conductor: #4/0 19-Strand Copper, compact round.
3. Construction: EPR insulation with stranded conductor and 6x#14 bare concentric neutral.
4. Provide #2 AWG copper ground wire with cable per PECO requirements.
5. Substitutions: See Section 016000 - Product Requirements.

2.3 ACCESSORIES

- A. Modular Cable Terminations: IEEE 48, Class 1, molded-rubber cable termination in kit form with stress cone, ground clamp, non-tracking rubber skirts, load break connector, rubber cap, and aerial lug.
- B. Tape Terminations: IEEE 48; Class 1, tape termination kit with semi-conductive tape, stress control tape, splicing tape, vinyl plastic tape, stress cone, mechanical ground straps, and cable preparation kit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conduit, duct, trench, or manholes are ready to receive cable.
- B. Verify routing and termination locations of cable bank prior to rough-in.
- C. Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

3.2 PREPARATION

- A. Use swab to clean conduits before pulling cables.

3.3 INSTALLATION

- A. Avoid abrasion and other damage to cables during installation.
- B. Use suitable lubricants and pulling equipment.
- C. Sustain cable pulling tensions and bending radii below recommended limits.
- D. Ground cable shield at each termination and splice.

- E. Install cables in manholes along wall providing longest route.
- F. Arrange cable in manholes to avoid interference with duct entrances.

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Section 014000.
- B. Inspect exposed cable sections for physical damage.
- C. Inspect cable for proper connections as indicated.
- D. Inspect shield grounding, cable supports, and terminations for proper installation.
- E. Inspect and test in accordance with NETA STD ATS, except Section 4.
- F. Perform inspections and tests listed in NETA STD ATS, Section 7.3.3.

3.5 PROTECTION

- A. Protect installed cables from entrance of moisture.

END OF SECTION 260513

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wire and cable for 600 volts and less.
- D. Wiring connectors.
- E. Electrical tape.
- F. Heat shrink tubing.
- G. Wire pulling lubricant.

1.2 RELATED REQUIREMENTS

- A. Section 078413 – Penetration Firestopping.
- B. Section 078443 – Joint Firestopping.
- C. Section 079200 – Joint Sealants
- D. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- E. Section 283100 - Fire Detection and Alarm: Fire alarm system conductors and cables.
- F. Section 315000 – Excavation Support and Protection.
- G. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2001 (Reapproved 2007).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2009).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2008.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association; 2006.
- I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).
- J. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- K. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- N. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- O. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- P. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- R. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Product Data: Provide for each cable assembly type.
- D. Test Reports: Indicate procedures and values obtained.
- E. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- F. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
- G. Project Record Documents: Record actual locations of components and circuits.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
- G. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
 - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
 - 2. In addition to other applicable restrictions, may not be used:
 - a. Where not approved for use by the authority having jurisdiction.
 - b. Where exposed to view.
 - c. Where exposed to damage.
 - d. For damp, wet, or corrosive locations.

- e. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.
- H. Concealed Dry Interior Locations: Use only building wire with Type THHN insulation in raceway.
- I. Exposed Dry Interior Locations: Use only building wire with Type THHN insulation in raceway.
- J. Above Accessible Ceilings: Use only building wire with Type THHN insulation in raceway.
- K. Wet or Damp Interior Locations: Use only building wire with Type THWN insulation in raceway.
- L. Exterior Locations: Use only building wire with Type THWN insulation in raceway.
- M. Underground Installations: Use only building wire with Type THWN insulation in raceway.
- N. Use solid conductor for feeders and branch circuits 10 AWG and smaller.
- O. Use stranded conductors for control circuits.
- P. Use conductor not smaller than 12 AWG for power and lighting circuits.
- Q. Use conductor not smaller than 18 AWG for control circuits.
- R. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
- S. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

2.2 CONDUCTOR AND CABLE MANUFACTURERS

- A. Cerro Wire LLC: www.cerrowire.com.
- B. Southwire Company: www.southwire.com.
- C. Substitutions: See Section 016000 - Product Requirements.

2.3 ALL CONDUCTORS AND CABLES

- A. Provide products that comply with requirements of NFPA 70.

- B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- H. Conductors for Grounding and Bonding: Also comply with Section 260526.
- I. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- J. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- K. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 200 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- M. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.

2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. Isolated Ground, All Systems: Green with yellow stripe.
 - e. Travelers for 3-Way and 4-Way Switching: Pink.
 - f. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
 - g. For control circuits, comply with manufacturer's recommended color code.

2.4 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com.
 - b. Encore Wire Corporation: www.encorewire.com.
 - c. Southwire Company: www.southwire.com.d. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.

- b. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.5 METAL-CLAD CABLE

A. Manufacturers:

- 1. AFC Cable Systems Inc: www.afcweb.com.
- 2. Encore Wire Corporation: www.encorewire.com.
- 3. Southwire Company: www.southwire.com.
- 4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:

- 1. Size 10 AWG and Smaller: Solid.
- 2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide dedicated neutral conductor for each phase conductor where indicated or required.

G. Grounding: Full-size integral equipment grounding conductor.

H. Armor: Steel, interlocked tape.

2.6 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 260526.

C. Wiring Connectors for Splices and Taps:

- 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
- 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Ideal Industries, Inc: www.idealindustries.com.
 - c. NSI Industries LLC: www.nsiindustries.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.

1. Manufacturers:
 - a. Burndy: www.burndy.com.
 - b. IlSCO: www.ilSCO.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

1. Manufacturers:
 - a. Burndy: www.burndy.com.
 - b. IlSCO: www.ilSCO.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.7 WIRING ACCESSORIES

A. Electrical Tape:

1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com.
 - c. Substitutions: See Section 016000 - Product Requirements.
2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Burndy: www.burndy.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. American Polywater Corporation: www.polywater.com.
 - c. Ideal Industries, Inc: www.idealindustries.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as shown on the drawings.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated and routing is not shown, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location shown.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 - 9. Provide oversized neutral/grounded conductors where indicated and as specified below.

- a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- H. Terminate cables using suitable fittings.
 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- I. Install conductors with a minimum of 12 inches of slack at each outlet.
- J. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- K. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.
- M. Insulate ends of spare conductors using vinyl insulating electrical tape.
- N. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078413, 078443, and 079200.
- P. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 014000.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Grounding and bonding components.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 033000 - Cast-in-Place Concrete.

1.3 REFERENCE STANDARDS

- A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; 1983.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.
- D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- F. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2011.
- G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms.

1.6 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Shop Drawings:
 1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Field quality control test reports.
- F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.7 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested according to IEEE 81 using "point-to-point" methods.
- E. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.

- b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
- 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
- 3. Metal Building or Structure Frame:
 - a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
- 4. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, located in softscape (uncovered) area.
- 5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- 6. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

F. Service-Supplied System Grounding:

- 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
- 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:

- 1. Provide grounding electrode system for each separate building or structure.

2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

H. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
5. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

I. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:

- a. Metal gas piping.

J. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

- L. Pole-Mounted Luminaires: Provide grounding of all exterior parking lot poles.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 260519:

1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
 - a. Burndy: www.burndy.com.
 - b. Harger Lightning & Grounding: www.harger.com.
 - c. Thomas & Betts Corporation: www.tnb.com.

d. Substitutions: See Section 016000 - Product Requirements.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
 - a. Erico International Corporation: www.erico.com.
 - b. Harger Lightning & Grounding: www.harger.com.
 - c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
 - a. Erico International Corporation: www.erico.com.
 - b. Galvan Industries, Inc: www.galvanelectrical.com.
 - c. Harger Lightning & Grounding: www.harger.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.3 PRODUCTS

A. Rod Electrodes: Copper.

1. Diameter: 3/4 inch.
2. Length: 10 feet.

B. Foundation Electrodes: 2/0 AWG.

2.4 CONNECTORS AND ACCESSORIES

A. Mechanical Connectors: Bronze.

B. Exothermic Connections:

C. Wire: Stranded copper.

D. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. Perform inspection in accordance with Section 014000.
- B. Inspect and test in accordance with NETA STD ATS except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260534 - Conduit: Additional support and attachment requirements for conduits.
- C. Section 260537 - Boxes: Additional support and attachment requirements for boxes.
- D. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- F. Conduit and equipment supports.
- G. Anchors and fasteners.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2011.
- D. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 3x. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.
3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Cooper Industries: www.cooperindustries.com.

- b. Erico International Corporation: www.erico.com.
 - c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - d. Thomas & Betts Corporation: www.tnb.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Cooper Industries: www.cooperindustries.com.
 - b. Erico International Corporation: www.erico.com.
 - c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - d. Thomas & Betts Corporation: www.tnb.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 4. Minimum Channel Thickness: 12 gauge.
 - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 - 6. Manufacturers:
 - a. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
 - b. Thomas & Betts Corporation: www.tnb.com.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - e. Outlet Boxes: 1/4 inch diameter.
 - f. Luminaires: 1/4 inch diameter.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Plastic and lead anchors are not permitted.
9. Powder-actuated fasteners are not permitted.
10. Hammer-driven anchors and fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: 12 gauge.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
12. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
13. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com.
 - c. Powers Fasteners, Inc: www.powers.com.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com.
 - e. Substitutions: See Section 016000 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Conduit Support and Attachment: Also comply with Section 260534.
- J. Box Support and Attachment: Also comply with Section 260537.
- K. Interior Luminaire Support and Attachment: Also comply with Section 265100.
- L. Exterior Luminaire Support and Attachment: Also comply with Section 265600.
- M. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- N. Secure fasteners according to manufacturer's recommended torque settings.
- O. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

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SECTION 260534 - CONDUIT

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Liquidtight flexible nonmetallic conduit (LFNC).
- H. Conduit fittings.
- I. Accessories.
- J. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 078413 – Penetration Firestopping.
- C. Section 078443 – Joint Firestopping.
- D. Section 079200 – Joint Sealants
- E. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC) and armored cable (Type AC), including uses permitted.
- F. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- G. Section 260529 - Hangers and Supports for Electrical Systems.

- H. Section 260537 - Boxes.
- I. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- J. Section 262701 - Electrical Service Entrance: Additional requirements for electrical service conduits.
- K. Section 271005 - Structured Cabling for Voice and Data - Inside-Plant: Additional requirements for communications systems conduits.
- L. Section 31500 – Excavation Support and Protection.
- M. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.
- E. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; National Electrical Contractors Association; 2004.
- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.

- J. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- L. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- M. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- N. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- P. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- Q. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- R. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
- 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
- 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
- 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

- 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Shop Drawings:
 - 1. Include proposed locations of roof penetrations and proposed methods for sealing.
- D. Project Record Documents: Record actual routing for conduits installed underground and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

PART 2 - PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular

application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use rigid PVC conduit.
2. Exterior, Direct-Buried: Use rigid PVC conduit.
3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.
2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges.

E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.

1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet in warehouse areas.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use

galvanized steel rigid metal conduit.

M. Corrosive Locations Above Ground: Use aluminum rigid metal conduit.

1. Corrosive locations include, but are not limited to:
 - a. Cooling towers.

N. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit.

O. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

1. Maximum Length: 6 feet.

P. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.2 PRODUCTS

A. Electrical Service Conduits: Also comply with Section 262701.

B. Communications Systems Conduits: Also comply with Section 271005.

C. Fittings for Grounding and Bonding: Also comply with Section 260526.

D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

E. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

F. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4 inch (21 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 1/2 inch (16 mm) trade size.
4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.

5. Underground, Interior: 3/4 inch (21 mm) trade size.
 6. Underground, Exterior: 1 inch (27 mm) trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.
4. Substitutions: See Section 016000 - Product Requirements.

- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.
4. Substitutions: See Section 016000 - Product Requirements.

- B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:

1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use aluminum.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:

1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:

1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.7 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Picoma: <http://www.picoma.com>.
4. Wheatland Tube Company: www.wheatland.com.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:

1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use compression (gland) type.
 - a. Do not use indenter type connectors and couplings.

2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

1. Cantex Inc: www.cantexinc.com.
2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
3. JM Eagle: www.jmeagle.com.
4. Substitutions: See Section 016000 - Product Requirements.

- ### B. Description:
- NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.9 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

- ### B. Description:
- NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.10 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.
- E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

F. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

G. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
14. Group parallel conduits in the same area together on a common rack.

H. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on

ceiling tiles.

4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.
10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

I. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

J. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment

openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.

8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

K. Underground Installation:

1. Provide trenching and backfilling in accordance with Sections 312316 and 315000.
2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape in accordance with Section 260553 along entire conduit length.

- L. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 033000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

- M. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

- N. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

- O. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

- P. Provide grounding and bonding in accordance with Section 260526.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective conduits.

END OF SECTION 260534

SECTION 260537 - BOXES

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Floor boxes.
- D. Underground handhole enclosures.
- E. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

- A. Section 078413 – Penetration Firestopping.
- B. Section 078443 – Joint Firestopping.
- C. Section 079200 – Joint Sealants
- D. Section 260526 - Grounding and Bonding for Electrical Systems.
- E. Section 260529 - Hangers and Supports for Electrical Systems.
- F. Section 262726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012

(ANSI/NEMA FB 1).

- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010) (ANSI/NEMA OS 1).
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, floor boxes, and underground handhole enclosures.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground handhole enclosures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc.

- (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit, or exposed intermediate metal conduit (IMC) is used.
 4. Use suitable concrete type boxes where flush-mounted in concrete.
 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
 6. Use raised covers suitable for the type of wall construction and device configuration where required.
 7. Use shallow boxes where required by the type of wall construction.
 8. Do not use "through-wall" boxes designed for access from both sides of wall.
 9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 13. Minimum Box Size, Unless Otherwise Indicated:
 14. Wall Plates: Comply with Section 262726.
 15. Manufacturers:
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:

D. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 262726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
2. Manufacturer: Same as manufacturer of floor box service fittings.

E. Underground Handhole Enclosures:

1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Applications:
 - a. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's

instructions and NFPA 70.

- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
 - 1. Locate boxes to be accessible.
- I. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 - 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
 - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Underground Handhole Enclosures:
 - 1. Install enclosure on gravel base, minimum 6 inches deep.

- 2. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
 - N. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
 - O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078413, 078443, and 079200.
 - P. Close unused box openings.
 - Q. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
 - R. Provide grounding and bonding in accordance with Section 260526.
- 3.3 CLEANING
- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.
- 3.4 PROTECTION
- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 260537

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 262726 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.
- C. Section 271005 - Structured Cabling for Voice and Data: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2007.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2007.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.7 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 - PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify incident energy, arc flash boundary, glove class, limit approach boundary, and restricted approach boundary.
 - 3) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Motor Control Centers:
 - 1) Identify voltage and phase.
 - 2) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Panelboards:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 4) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - d. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - e. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify load(s) served. Include location when not within sight of equipment.
 - f. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 4) Identify load(s) and associated circuits controlled. Include location.
 - g. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
2. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.

- b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
3. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
4. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 by 5 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
5. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
6. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
7. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
8. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Identification for Communications Conductors and Cables: Comply with Section 271005.
3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
4. Use underground warning tape to identify direct buried cables.

C. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 271005.
2. Wiring Device and Wallplate Finishes: Comply with Section 262726.

3. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.

2.2 PRODUCTS

A. Identification Nameplates:

1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 - c. Seton Identification Products: www.seton.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com.
 - b. Brother International Corporation: www.brother-usa.com.
 - c. Panduit Corp: www.panduit.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.

2. Legend:
 - a. System designation where applicable:
 - 1) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 - c. Other information as indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

G. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

H. Locations:

1. Each electrical distribution and control equipment enclosure.
2. Communication cabinets.

I. Letter Size:

1. Use 1/8 inch letters for identifying individual equipment and loads.
2. Use 1/4 inch letters for identifying grouped equipment and loads.

J. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations.

K. Wire Markers

1. Manufacturers:
2. Brady Corporation; Model: www.bradyid.com.
3. HellermannTyton; Model: www.hellermannityton.com.
4. Panduit Corp: www.panduit.com.
 - a. Substitutions: See Section 016000 - Product Requirements.

L. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

M. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

N. Legend: Power source and circuit number or other designation indicated.

O. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

1. Do not use handwritten text.

P. Minimum Text Height: 1/8 inch.

Q. Color: Black text on white background unless otherwise indicated.

2.3 VOLTAGE MARKERS

2.4 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Brady Corporation; Model: www.bradyid.com.
2. Brimar Industries, Inc: www.brimar.com.
3. Seton Identification Products; Model: www.seton.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:

1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.5 WARNING SIGNS AND LABELS

A. Manufacturers:

1. Brimar Industries, Inc: www.brimar.com.
2. Clarion Safety Systems, LLC: www.clarionsafety.com.
3. Seton Identification Products: www.seton.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:

1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester, or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant;

produced using materials recognized to UL 969.

- a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conductors and Cables: Legible from the point of access.
 8. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing, or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

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SECTION 260573 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Short-circuit study.
- B. Protective device coordination study.
- C. Arc flash and shock risk assessment.
- D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.2 RELATED REQUIREMENTS

- A. Section 260553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.
- B. Section 262413 - Switchboards.
- C. Section 262416 - Panelboards.
- D. Section 262813 - Fuses.
- E. Section 262816.13 - Enclosed Circuit Breakers.
- F. Section 262816.16 - Enclosed Switches.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011 (Reaffirmed 2017).
- B. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).
- C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).
- D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.
- E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

- F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations; 2018, with Errata (2019).
- G. NEMA MG 1 - Motors and Generators; 2021.
- H. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
 - 2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.
 - 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
- C. Scheduling:
 - 1. Arrange access to existing facility for data collection with Owner.
 - 2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Study preparer's qualifications.
- C. Field testing agency's qualifications.
- D. Study reports, stamped or sealed and signed by study preparer.
- E. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
 - 1. Include characteristic time-current trip curves for protective devices.

2. Include impedance data for engine generators.
 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 4. Include documentation of listed series ratings upon request.
 5. Identify modifications made in accordance with studies that:
 - a. Can be made at no additional cost to Owner.
 - b. As submitted will involve a change to the contract sum.
- F. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.
- G. Site-specific arc flash hazard warning labels.
- H. Field quality control reports.
- I. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
- J. Project Record Documents: Revise studies as required to reflect as-built conditions.
1. Include hard copies with operation and maintenance data submittals.
 2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.6 POWER SYSTEM STUDIES

- A. Scope of Studies:
1. Perform analysis of both new and existing portions of electrical distribution system.
 2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
 3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
 - a. Known Operating Modes:
 - 1) Utility as source.
 - 2) Generator as source.
 - 3) Maintenance settings.
- B. General Study Requirements:
1. Comply with NFPA 70.
 2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
- C. Data Collection:
1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.

- a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
 - 1) Obtain up-to-date information from Utility Company.
 - 2) Utility Company: As indicated on drawings.
 - b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
 - c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
 - d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
 - e. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
 - f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
 - g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
 - 2. Existing Installations:
 - a. Provide the services of field testing agency to perform field data collection.
 - b. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.
- D. Short-Circuit Study:
- 1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
 - 2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
 - a. Maximum utility fault currents.
 - b. Maximum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 - 3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

- E. Protective Device Coordination Study:
 - 1. Comply with applicable portions of IEEE 242 and IEEE 399.
 - 2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 - 3. Analyze protective devices and associated settings for suitable margins between time-current curves to provide adequate protection for equipment and conductors while achieving full selective coordination.
- F. Arc Flash and Shock Risk Assessment:
 - 1. Comply with NFPA 70E.
 - 2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
 - 3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
 - a. Maximum and minimum utility fault currents.
 - b. Maximum and minimum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
- G. Study Reports:
 - 1. General Requirements:
 - a. Identify date of study and study preparer.
 - b. Identify study methodology and software product(s) used.
 - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
 - d. Identify base used for per unit values.
 - e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
 - f. Include conclusions and recommendations.
 - 2. Short-Circuit Study:
 - a. For each scenario, identify at each bus location:
 - 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
 - 2) Fault point X/R ratio.
 - 3) Associated equipment short circuit current ratings.
 - b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
 - 3. Protective Device Coordination Study:
 - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
 - b. For each graph include (where applicable):

- 1) Partial single-line diagram identifying the portion of the system illustrated.
- 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
- 3) Conductors: Damage curves.
- 4) Transformers: Inrush points and damage curves.
- 5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
- 6) Motors: Full load current, starting curves, and damage curves.
- 7) Capacitors: Full load current and damage curves.
- c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
 - 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
 - 2) Include ground fault pickup and delay.
 - 3) Include fuse ratings.
 - 4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
- d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
4. Arc Flash and Shock Risk Assessment:
 - a. For the worst case for each scenario, identify at each bus location:
 - 1) Calculated incident energy and associated working distance.
 - 2) Calculated arc flash boundary.
 - 3) Bolted fault current.
 - 4) Arcing fault current.
 - 5) Clearing time.
 - 6) Arc gap distance.
 - b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
 - c. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 40 calories per sq cm.

1.7 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in preparation of studies of similar type and complexity using specified computer software.

1. Study preparer may be employed by manufacturer of electrical distribution equipment.
 2. Study preparer may be employed by field testing agency.
- B. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.
1. Field Supervisor: Certified electrical testing technician; NETA ETT Level III.
- C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
1. Products:
 - a. EasyPower LLC: www.easypower.com/#sle.
 - b. ETAP/Operation Technology, Inc: www.etap.com/#sle.
 - c. Power Analytics Corporation: www.poweranalytics.com/#sle.
 - d. SKM Systems Analysis, Inc: www.skm.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

PART 2 PRODUCTS

2.1 ARC FLASH HAZARD WARNING LABELS

- A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
1. Materials: Comply with Section 260553.
 2. Minimum Size: 4 by 6 inches.
 3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
 - a. Include orange header that reads "WARNING" unless otherwise indicated.
 - b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
 - c. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Site-specific PPE (personnel protective equipment) requirements.
 - 4) Nominal system voltage.
 - 5) Limited approach boundary.
 - 6) Restricted approach boundary.
 - 7) Equipment identification.
 - 8) Study preparer, report reference, and date calculations were performed.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install arc flash warning labels in accordance with Section 260553.

3.2 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Adjust equipment and protective devices for compliance with studies and recommended settings.
- E. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.
- F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.3 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
 - 1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Representative of entity performing study.
 - 4. Location: At project site.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Occupancy sensors.
- B. Outdoor photo controls.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260537 - Boxes.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 262726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, fan speed controllers, and wall plates.
- E. Section 265100 - Interior Lighting.
- F. Section 265200 – Gymnasium Theatrical Lighting.

1.3 REFERENCE STANDARDS

- A. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment - Nonlocking (Button) Type Photocontrols; 2004 (R2010).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- D. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 773 - Plug-in Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

- G. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.
- H. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.
- I. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:

1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.

D. Field Quality Control Reports.

- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Include detailed information on device programming and setup.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
- H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all occupancy sensors.

PART 2 - PRODUCTS

2.1 ALL LIGHTING CONTROL DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
- C. Products for Switching of Electronic Fluorescent Ballasts: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.2 OCCUPANCY SENSORS

A. Manufacturers:

- 1. Hubbell Building Automation, Inc: www.hubbellautomation.com
- 2. WattStopper: www.wattstopper.com.
- 3. Leviton: www.leviton.com
- 4. Acuity
- 5. Lutron
- 6. Substitutions: See Section 016000 - Product Requirements.
- 7. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. All Occupancy Sensors:

- 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
- 2. Sensor Technology:
 - a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
 - b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
 - c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
- 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.

4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
7. Turn-Off Delay: Field adjustable, up to a maximum time delay setting of not less than 15 minutes and not more than 30 minutes.
8. Sensitivity: Field adjustable.
9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
10. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above the selected level.
11. Compatibility: Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
12. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on the drawings.
13. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

C. Wall Switch Occupancy Sensors:

1. All Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Unless otherwise indicated or required to control the load indicated on the drawings, provide line voltage units with self-contained relay.
 - c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
 - d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - c. Provide field selectable setting for disabling LED motion detector visual indicator.
 - d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 - e. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
3. Ultrasonic Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 500 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet.
4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.

E. Power Packs for Low Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control the load indicated on the drawings.

2.3 OUTDOOR PHOTO CONTROLS

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com.
2. Paragon, a brand of Invensys Controls: www.invensyscontrols.com.
3. Tork, a division of NSI Industries LLC: www.tork.com.

4. Substitutions: See Section 016000 - Product Requirements.
5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Stem-Mounted Outdoor Photo Controls:

1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
2. Housing: Weatherproof, impact resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Provide external sliding shield for field adjustment of light level activation.
5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
6. Voltage: As required to control the load indicated on the drawings.
7. Failure Mode: Fails to the on position.
8. Load Rating: As required to control the load indicated on the drawings.
9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

C. Locking Receptacle-Mounted Outdoor Photo Controls

1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.
2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.
8. Surge Protection: 160 joule metal oxide varistor.

D. Button Type Outdoor Photo Controls

1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of lighting control devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Occupancy Sensors: 48 inches above finished floor to the top of the box.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.
- G. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- H. Identify lighting control devices in accordance with Section 260553.
- I. Occupancy Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
 - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- J. Outdoor Photo Control Locations:
 - 1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
 - 2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.
- K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.
- L. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.
- M. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.

- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Test outdoor photo controls to verify proper operation, including time delays where applicable.
- E. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
- D. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
 - 4. Location: At project site.

END OF SECTION 260923

SECTION 260924 – DISTRIBUTED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Distributed Digital Lighting Control System: System includes
 - 1. Digital Lighting and Plug Load Controls
 - 2. Relay Panels
 - 3. Emergency Lighting Control.

1.2 RELATED SECTIONS

- A. Section 27 0539 - Surface Raceways for Communications Systems
- B. Section 26 5100 – Interior Lighting.
- C. Section 23 0993 – HVAC Control Sequence - Integrated Automation, Building integrator shall provide integration of the lighting control system with Building Automation Systems.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.
- B. NEMA - National Electrical Manufacturers Association
- C. FCC emission standards
- D. UL - Underwriters Laboratories, Inc. Listings
- E. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces.
- F. UL 20 - General Use Switches, Plug Load Controls
- G. UL 924 - Standard for Emergency Lighting and Power Equipment
- H. ULC - Underwriter Laboratories of Canada Listings

1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.
- B. System shall conform to requirements of NFPA 70.

- C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.
- D. System shall be listed under UL sections 916 and/or 508.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 3000 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Catalog sheets and specifications.
 - 2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation instructions.
- C. Shop Drawings: Wiring diagrams a for the various components of the System specified including:
 - 1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
 - 2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
 - 3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
 - 4. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- E. Closeout Submittals:
 - 1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
 - 2. Operation and Maintenance Manual:
 - a. Include approved Shop Drawings and Product Data.
 - b. Include Sequence of Operation, identifying operation for each room or space.
 - c. Include manufacturer's maintenance information.
 - d. Operation and Maintenance Data: Include detailed information on device programming and setup.
 - e. Include startup and test reports.
- F. Title 24 Acceptance Testing Documentation: Submit Certification of Acceptance and associated documentation for lighting control acceptance testing performed in accordance with CAL TITLE 24 P6, as specified in Part 3 of this specification under "COMMISSIONING".

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.
- B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.
- C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.7 PRE-INSTALLATION MEETINGS

- A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Architect, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.
- B. Review installation procedures and coordination required with related Work and the following:
 - 1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 - 2. Review the specifications for low voltage control wiring and termination.
 - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - 4. Discuss requirements for integration with other trades
- C. Inspect and make notes of job conditions prior to installation:
 - 1. Record minutes of the conference and provide copies to all parties present.
 - 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 - 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation

1.9 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
2. Relative humidity: Maximum 90 percent, non-condensing.

1.10 WARRANTY

- A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.
- B. Warranty period shall not start until substantial completion of the project.

PART 2 PRODUCTS

2.1 MANUFACTURERS (**Addendum 3**)

- A. Acceptable Manufacturer: WattStopper, which is located at: 2700 Zanker Rd., Suite 168; San Jose, CA 95134; Tel: 408.988.5331; Fax: 408.988.5373; Email: [request info \(\)](mailto:request_info ()); Web: www.wattstopper.com
- B. Substitutions: **Hubbell Current Nx**, Acquity NLight, Lutron, **Cooper Greengate**
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 6000 - Product Requirements.

2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

- A. System General: Provide a WattStopper Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.
 1. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room.
 2. Daylit Areas: Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code or as indicated on drawings:
 - a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
 - c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.

- d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
 3. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
 3. Digital Fixture Controllers: Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
 4. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 5. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 6. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
 7. Configuration Tools: Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
 8. Digital Lighting Management (DLM) segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.
 9. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
 10. Wireless Network Bridge and Border Router: Provides Wireless Network Bridges that automatically create BACnet objects for all DLM devices on their local network (room) and communicate that information over a standalone wireless mesh 6LoWPAN network to a Border Router. The Border Router manages the formation and communication of the mesh network, and provides an ethernet network connection to upstream intelligent devices, such as a Segment Manager.

11. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
 12. Programming and Configuration Software: Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
 13. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.
 14. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building
- C. Local Network LMRJ-Series: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
1. Features of the DLM local network include:
 - a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
 - c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
 2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
 3. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.3 DIGITAL LOAD CONTROLLERS (ROOM AND FIXTURE CONTROLLERS)

- A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting control requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
 3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
 4. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 5. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
 7. Each load be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
 8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
 9. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Schedule state, normal or after-hours
 - c. Demand Response enable and disable
 - d. Room occupancy status
 - e. Total room lighting and plug loads watts
 - f. Electrical current
 - g. Total watts per controller
 - h. Total room watts/sq ft.
 - i. Force on/off all loads
 10. UL 2043 plenum rated
 11. Manual override and LED indication for each load
 12. Zero cross circuitry for each load

13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
 14. Dimming Room Controllers shall share the following features:
 - a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
 - b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - c. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - 1) Establish preset level for each load from 0-100 percent
 - 2) Set high and low trim for each load
 - d. Override button for each load provides the following functions:
 - 1) Press and release for on/off control
 - 2) Press and hold for dimming control
 - e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 - g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
 - h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
- B. On/Off Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load
 2. One or two relay configuration
 3. Simple 150 mA switching power supply (Only 4 100 series devices on a Cat 5e local network)
 4. Three RJ-45 DLM local network ports with integral strain relief and dust cover
 5. WattStopper product numbers: LMRC-101, LMRC-102
- C. On/Off/0-10V Dimming Enhanced Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
 2. Built in real time current monitoring
 3. One, two or three relays configurations
 4. Smart 250 mA switching power supply
 5. Four RJ-45 DLM local network ports. Provide integral strain relief
 6. One dimming output per relay

- a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting (LMRC-110 series and 210 series).
 7. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213.
- D. On/Off/ Forward Phase Dimming Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) rated for 20A total load, with forward phase dimmed loads derating to 16A for some load types
 2. Built in real time current monitoring
 3. One or two relays configurations
 4. Smart 250 mA switching power supply
 5. Four RJ-45 DLM local network ports. Provide integral strain relief
 6. One dimming output per relay
 - a. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-220 series)
 7. WattStopper product numbers: LMRC-221, LMRC-222
- E. Fixture Controllers shall include
1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
 2. One 3A 120/277V rated mechanically held relay.
 3. Programmable behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
 4. Requirement for 7 mA of 24VDC operating power from the DLM local network.
 5. Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the DLM local network to drive accessory devices.
 6. Power to drive the LMFC Fixture Controller electronics can come from any Room or Plug Load Controller, LMPB-100 Power Booster and/or LMZC-301 Zone Controller
 7. 0-10V dimming capability via a single 0-10 volt analog output from the device for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.
 8. Connect to a single or dual RJ-45 adaptor with 24 inch leads. Single adaptor mounts in a 1/2 inch KO and dual adaptor in a 2.2 by 1.32 inch rectangular hole for connection to the DLM local network.
 9. Adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.

10. A complete set of dimming features described above in the paragraph detailing On/Off/Dimming Enhanced Room Controllers.
 - a. WattStopper product numbers: Fixture Controller: LMFC-011, DLM Cable Connector: LMFC-RJ-50-24 or LMFC-2RJ, Power Booster: LMPB-100.

2.4 DIGITAL WALL OR CEILING MOUNTED WIRELESS OCCUPANCY SENSOR

- A. Digital Occupancy Sensors shall provide digital calibration and electronic documentation. Features include the following:
 1. Digital calibration for the following variables:
 - a. Sensitivity, 0-100 percent in 10 percent increments
 - b. Time delay, 1-30 minutes in 1 minute increments
 - c. Test mode, Five second time delay
 - d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - e. Ultrasonic and Passive Infrared
 - f. Ultrasonic or Passive Infrared
 - g. Ultrasonic only
 - h. Passive Infrared only
 - i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Wireless connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 6. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 7. Manual override of controlled loads.
 8. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
 9. Operation on an included CR123A battery providing a 10+ year lifespan.

- B. BACnet object information shall be available for the following objects:
 - 1. Detection state
 - 2. Occupancy sensor time delay
 - 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- C. Units shall not have any dip switches or potentiometers for field settings
- D. WattStopper product numbers: LMPX,LMPC

2.5 DIGITAL WALL SWITCH OCCUPANCY SENSORS

- A. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
 - 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity: 0-100 percent in 10 percent increments
 - b. Time delay: 1-30 minutes in 1 minute increments
 - c. Test mode: Five second time delay
 - d. Detection technology: PIR, Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 - 2. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - 1) Ultrasonic and Passive Infrared
 - 2) Ultrasonic or Passive Infrared
 - 3) Ultrasonic only
 - 4) Passive Infrared only
 - 3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 - 4. Two RJ-45 ports for connection to DLM local network.
 - 5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
 - 6. Device Status LEDs including
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding

7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
 8. Assignment of local buttons to specific loads within the room without wiring or special tools
 9. Manual override of controlled loads
 10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
 4. Button state
 5. Switch lock control
 6. Switch lock status
- C. Units shall not have any dip switches or potentiometers for field settings.
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- E. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
1. Left button
 - a. Press and release - Turn load on
 - b. Press and hold - Raise dimming load
 2. Right button
 - a. Press and release - Turn load off
 - b. Press and hold - Lower dimming load
- F. Low voltage momentary pushbuttons shall include the following features:
1. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 2. The following button attributes may be changed or selected using a wireless configuration tool:
 - a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - b. Individual button function may be configured to Toggle, On only or Off only.
 - c. Individual scenes may be locked to prevent unauthorized change.
 - d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - e. Ramp rate may be adjusted for each dimmer switch.
 - f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

- g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.6 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.
 - 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 - 5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
 - 6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
 - 1. Button state
 - 2. Switch lock control
 - 3. Switch lock status
- C. Two RJ-45 ports for connection to DLM local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
 - 1. Individual button function may be configured to Toggle, On only or Off only.
 - 2. Individual scenes may be locked to prevent unauthorized change.
 - 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - 4. Ramp rate may be adjusted for each dimmer switch.

5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
6. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.7 DIGITAL DAYLIGHTING SENSORS

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
 1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
 2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
 3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone
- B. Digital daylighting sensors shall include the following features:
 1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
 3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
 5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
 6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
 7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
 8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
 9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.

10. Configuration LED status light on device that blinks to indicate data transmission.
 11. Status LED indicates test mode, override mode and load binding.
 12. Recessed switch on device to turn controlled load(s) ON and OFF.
 13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints
 - e. Up to three zone setpoints
 - f. Operating mode - on/off, bi-level, tri-level or dimming
 14. One RJ-45 port for connection to DLM local network.
 15. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.
 16. Any load or group of loads in the room can be assigned to a daylighting zone
 17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
 18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.
- C. Closed loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
 2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
 3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
 4. WattStopper Product Number: LMLS-400, LMLS-400-L.
- D. Open loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
 2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.

3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
 4. WattStopper Product Number: LMLS-500, LMLS-500-L.
- E. Dual loop digital photosensors shall include the following additional features:
1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this con
 2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
 3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.
 4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
 5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
 6. Device must include extendable mounting arm to properly position sensor within a skylight well.
 7. WattStopper product number LMLS-600

2.8 DIGITAL PARTITION CONTROLS

- A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.
- B. Four-button low voltage pushbutton switch for manual control.
1. Two-way infrared (IR) transceiver for use with configuration remote control.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Each button represents one wall; Green button LED indicates status.
 5. Two RJ-45 ports for connection to DLM local network.
 6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.
- C. Coordinate contact closure interface for automatic control via input from limit switches on movable walls specified in Section 10 22 43 - Sliding Partitions .
1. Operates on Class 2 power supplied by DLM local network.

2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
3. Input max. sink/source current: 1-5mA
4. Logic input signal voltage High: > 18VDC
5. Logic input signal voltage Low: < 2VDC
6. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
7. Two RJ-45 ports for connection to DLM local network.
8. WattStopper part number: LMIO-102

2.9 HANDHELD CONFIGURATION TOOLS

- A. Provide a wireless configuration tool to facilitate customization of DLM local networks using two-way infrared communications, and/or PC software that connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
 1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.
 4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
 5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
 7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 8. Verify status of building level network devices.
- C. WattStopper Product Numbers: Handheld LMCT-100

2.10 DLM SEGMENT NETWORK

- A. Provide a segment network using linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
 1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.

3. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
4. Network wire jacket is available in high visibility green, white, or black.
5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
6. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
7. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an NB-ROUTER or LMSM Unit. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable

B. WattStopper Product Number: LM-MSTP, LM-MSTP-W, LM-MSTP-B, LM-MSTP-DB

2.11 NETWORK BRIDGE

- A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
 3. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller

- h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
- i. Activate a preset scene for the room
- j. Read/write daylight sensor fade time and day and night setpoints
- k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
- l. Set daylight sensor operating mode
- m. Read/write wall switch lock status
- n. Read watts per square foot for the entire controlled room
- o. Write maximum light level per load for demand response mode
- p. Read/write activation of demand response mode for the room
- q. Activate/restore demand response mode for the room

B. WattStopper product numbers: LMBC-300

2.12 WIRELESS NETWORK BRIDGES AND BORDER ROUTER

A. Wireless Network Bridges connect to a DLM local network (room) and use IEEE 802.15.4 6LoWPAN for communication between rooms and to a Border Router that oversees the formation and configuration of the wireless network. Each local network shall include a wireless network bridge that connects to the other DLM devices on the local network, and a group of Wireless Bridges shall connect to a Border Router.

B. Features of the Wireless Network Bridges shall be as follows:

- 1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
- 2. Wireless Bridges provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the Border Router via the wireless network. No commissioning shall be required for set up of the network bridge on the local network.
- 3. Wireless Bridges shall incorporate dual internal omni-directional antennas with diversity to provide wide and robust communication, and so the antennas will be protected against accidental contact with other objects in the space.
- 4. Two LEDs shall be included on the bridge to provide feedback about the local network (red) and wireless network (blue) health.
- 5. Wireless Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads

- e. Read/write the dimmed light level of loads
- f. Read the button states of switches
- g. Read total current in amps, and total power in watts through the load controller
- h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
- i. Activate a preset scene for the room
- j. Read/write daylight sensor fade time and day and night setpoints
- k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
- l. Set daylight sensor operating mode
- m. Read/write wall switch lock status
- n. Read watts per square foot for the entire controlled room
- o. Write maximum light level per load for demand response mode
- p. Read/write activation of demand response mode for the room
- q. Activate/restore demand response mode for the room

C. Features of the Wireless Border Router shall be:

- 1. The Wireless Border Router shall manage the formation and configuration of the 6LoWPAN wireless mesh network, and provide connectivity via wired 10/100 Ethernet to a local area network that may include a LSM Segment Manager or Building BAS System.
- 2. Border Router shall provide key information about the health of the mesh network in the form of signal quality, device status, network status, and other real-time network information such as energy monitoring.
- 3. The LMBR-600 shall have dual internal omni-directional antennas with diversity to ensure reliable communication with Wireless Network Bridges, and provide a user interface for set up and configuration.
- 4. Include an internal MicroSD card and a Real-time clock with supercap back-up. Border Router shall get power for operation via a 120V outlet (in non-plenum applications) and a dedicated DLM LMPB-100 Power Booster connected to a Cat 5e to DC barrel connector (for plenum applications)

D. Communication between the Wireless Network Bridges and the Border Router

- 1. The communication between the Wireless Bridges and the Border Router shall be via a standalone wireless mesh network that does not require interface with any other wireless network in the space. The mesh network shall allow communication between all rooms as long as they are within 100' of another connected room.
- 2. The Wireless Bridges shall communicate over a 6LoWPAN 2.4 GHz IEEE 802.15.4 network and use AES 128 bit Key Encryption for network security.
- 3. In addition to IEEE IPV6, the Border Router shall have available Constrained Application Protocol (CoAP), Routing Protocol for Low Power Networks (RPL), and Stateless Multicast RPL Forwarding (SMRF).
- 4. The wireless protocol shall allow BACnet communication to be transported transparently between the Network Bridge and any front end BAS devices such as the LSM Segment Manager.

- E. WattStopper product numbers: Wireless Network Bridge LMBC-600, Wireless Border Router LMBR-600.

2.13 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

- A. Hardware: Provide LMCP lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:
1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
 2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
 3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
 - a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
 - b. Individual terminal block, override pushbutton, and LED status light for each relay.
 - c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
 - d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
 - e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
 - f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
 - h. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.

4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
 - a. Electrical:
 - 1) 30 amp ballast at 277V
 - 2) 20 amp ballast at 347V
 - 3) 20amp tungsten at 120V
 - 4) 30 amp resistive at 347V
 - 5) 1.5 HP motor at 120V
 - 6) 14,000 amp short circuit current rating (SCCR) at 347V
 - 7) Relays shall be specifically UL 20 listed for control of plug-loads
 - b. Mechanical:
 - 1) Replaceable, 1/2 inch KO mounting with removable Class 2 wire harness.
 - 2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - 3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
 - 4) Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
 - a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 tnetworked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
 - d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - 1) Scheduled ON / OFF
 - 2) Manual ON / Scheduled OFF
 - 3) Astro ON / OFF (or Photo ON / OFF)
 - 4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)

- e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
 - f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.
- a. Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
 - b. Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
 - c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
 - d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.
 - e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
 - f. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - 1) Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
 - 2) Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
 - 3) Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
 - 4) Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of

- sweep type automatic wall switches.
- g. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
 - h. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
 - i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
 - j. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
- a. Use the same intelligence board as the LMCP relay panel.
 - b. Shall not include relay driver boards or relays.
 - c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
 - d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
 - e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50 percent output when any digital occupancy sensor detects motion.
13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone Controller: LMZC-301.
- B. User Interface: Each lighting control panel system shall be supplied with at least one handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. User interface shall have the following panel-specific functions as a minimum:
- 1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 - 2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.

3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
7. WattStopper Product Number: LMCT-100

2.14 SEGMENT MANAGER

- A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).
- B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.
- C. Operational features of the Segment Manager shall include the following:
 1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Segment Manager shall provide two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
 - a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.

- b. Allow information for all discovered DLM devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager
 - c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
 - d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
 - e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
5. Capabilities using the Segment Manager's Dashboard Screens shall include:
- a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers such as LMRC-21x). Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.
 - b. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by

- day, week or month.
 - c. For fixtures that are accessible via the Segment Network, and have CCT capability as specified under paragraph Digital Wall Switch and Timer For Correlated Color Temperature, the Segment Manager will provide schedule functionality similar to the CCT Wall Timer, allowing all CCT fixtures across the entire facility to be scheduled together.
 - d. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).
 - 6. If shown on the Drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
 - 7. Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.
- D. Segment Manager v2.2 and later shall support multiple DLM rooms as follows:
- 1. Support up to 120 network bridges and 750 digital in-room devices (LMSM-3E).
 - 2. Support up to 200 network bridges and 1,100 digital in room devices, connected via network routers and switches (LMSM-6E).
- E. WattStopper Product Numbers: LMSM-3E, LMSM-6E, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.15 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

- A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.
- B. Additional parameters exposed through this method include but are not limited to:
- 1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
 - 2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
 - 3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.

4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
 5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
 6. Load control polarity reversal so that on events turn loads off and vice versa.
 7. Per-load DR (demand response) shed level in units of percent.
 8. Load output pulse mode in increments of 1second.
 9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
- C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
1. Device list report: All devices in a project listed by type.
 2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
 5. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
 6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
 7. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.
- D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
1. Set, copy/paste an entire project site of sensor time delays.
 2. Set, copy/paste an entire project site of sensor sensitivity settings.
 3. Search based on room name and text labels.
 4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.
 5. Filter by parameter value to search for product with specific configurations.
- E. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
 2. Mass firmware update of specifically selected rooms or areas.
 3. Mass firmware upgrade of specific products
- F. WattStopper Product Number: LMCS-100, LMCI-100

2.16 EMERGENCY LIGHTING CONTROL DEVICES

- A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface
- B. WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 EXECUTION

3.1 PREPARATION

- A. Do not begin installation until measurements have been verified and work areas have been properly prepared.
- B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

3.2 INSTALLATION

- A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.
- B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
 - 1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
 - 2. If fixtures have internal DLM Control Modules, ensure that they are also connected with Cat 5e cable.
 - 3. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire or wireless devices. Network wire substitution is not permitted and may result in loss of product warranty.
 - 4. Low voltage wiring topology must comply with manufacturer's specifications.
 - 5. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

- C. All line voltage connections shall be tagged to indicate circuit and switched legs.
 - D. Test all devices to ensure proper communication.
 - E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.
 - F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
 - G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.
 - H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.
 - I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.
 - J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
 - K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.
 - L. Remote Access for Network Systems: Ensure Segment Manager enclosure is installed in a location with good to excellent cellular phone coverage based on building orientation and geographic location, and mount magnetic antenna for the modem. For cases where alternate mounting locations are not available and a stronger cellular signal is needed, the manufacturer shall offer additional antenna options to improve signal quality. Verify final mounting location with Engineer and Owner prior to proceeding with the Work.
 - M. Provide integration to Building Management System.
 - N. Provide system start-up after completion of each phase of construction.
- 3.3 FIELD QUALITY CONTROL
- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.

- B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
1. Verify Class I and II wiring connections are terminated properly by validating system performance.
 2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
 3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
 4. Verify that the control of each space complies with the Sequence of Operation.
 5. Correct any system issues and retest.
- C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
1. Date of test or inspection.
 2. Loads per space, or Fixture Address identification.
 3. Quantity and Type of each device installed
 4. Reports providing each device's settings.

3.4 COMMISSIONING ASSISTANCE

- A. Title 24 Acceptance Testing Service; Include additional costs for Lighting Control Manufacturer to provide a technician for one additional day while the CLCATT performs lighting control acceptance testing in accordance with CAL TITLE 24 P6 including submission of required documentation.

3.5 DEMONSTRATION AND TRAINING

- A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:
1. Confirmation of entire system operation and communication to each device.
 2. Confirmation of operation of individual relays, switches, and sensors.
 3. Confirmation of system Programming, photocell settings, override settings, etc.
 4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

3.6 PRODUCT SUPPORT AND SERVICE

- A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION 26 0924

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SECTION 262100 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical service requirements.

1.2 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Materials and installation requirements for cast-in-place concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0533.13 - Conduit for Electrical Systems.
- E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 2413 - Switchboards: Service entrance equipment.
 - 1. Includes non-utility electrical metering.
- G. Section 26 2416 - Panelboards: Service entrance equipment.
- H. Section 26 2713 - Electricity Metering: Non-utility electrical metering.
- I. Section 26 2816.16 - Enclosed Switches: Service entrance equipment.
- J. Section 26 3213 - Engine Generators: Emergency/standby power systems for interconnection with normal utility electrical supply.
- K. Section 26 3600 - Transfer Switches: Service entrance equipment.
- L. Section 26 4300 - Surge Protective Devices: Service entrance surge protective devices.
- M. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 DEFINITIONS

- A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.4 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. No later than two weeks following date established in Notice to Proceed, notify Utility Company of anticipated date of service.
- B. Coordination:
 - 1. Verify the following with Utility Company representative:
 - a. Utility Company requirements, including division of responsibility.
 - b. Exact location and details of utility point of connection.
 - c. Utility easement requirements.
 - d. Utility Company charges associated with providing service.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
 - 3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.
- D. Utility Company charges associated with providing permanent service to be paid by Owner.
- E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.
- F. Scheduling:
 - 1. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.6 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.
- C. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.
 - 1. Obtain Utility company approval of shop drawings prior to submittal.
- D. Drawings prepared by Utility Company.
- E. Project Record Documents: Record actual locations of equipment and installed service routing.

1.7 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. IEEE C2 (National Electrical Safety Code).
 - 2. NFPA 70 (National Electrical Code).
 - 3. The requirements of the Utility Company.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 ELECTRICAL SERVICE REQUIREMENTS

- A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.
- B. Electrical Service Characteristics: As indicated on drawings.
- C. Utility Company: PECO Energy Company
 - 1. Point of Contact:
 - 2. Phone:
 - 3. Email:
 - 4. Utility Company Project Reference Number:
- D. Division of Responsibility:
 - 1. Pad-Mounted Utility Transformers:
 - a. Transformer Vaults and Pads: Furnished and installed by Contractor per Utility Company requirements.
 - b. Transformers: Furnished and installed by Utility Company.
 - c. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.
 - d. Transformer Protective Bollards: Furnished and installed by Contractor per Utility Company requirements.
 - e. Primary:
 - 1) Trenching and Backfilling: Provided by Contractor.
 - 2) Conduits: Furnished and installed by Contractor.
 - 3) Conductors: Furnished and installed by Contractor.
 - f. Secondary:
 - 1) Trenching and Backfilling: Provided by Contractor.
 - 2) Conduits: Furnished and installed by Contractor.
 - 3) Conductors: Furnished and installed by Contractor.
 - 2. Terminations at Service Point: Provided by Utility Company.
 - 3. Metering Provisions:
 - a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.
- E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Verify and mark locations of existing underground utilities.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions and Utility Company requirements.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Provide required trenching and backfilling in accordance with Section 31 2316.13.
- E. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements and Section 03 3000.
- F. Provide required protective bollards in accordance with Utility Company requirements.
- G. Provide required support and attachment components in accordance with Section 26 0529.
- H. Provide grounding and bonding for service entrance equipment in accordance with Section 26 0526.
- I. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 0553.

3.4 PROTECTION

- A. Protect installed equipment from subsequent construction operations.

END OF SECTION 262100

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SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General purpose transformers.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 260534 - Conduit: Flexible conduit connections.
- E. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

- A. IEEE C57.94 - Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; 1982 (R2006).
- B. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 1999 (R2004).
- C. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2009.
- D. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; 1992 (R1997).
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008
- F. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; 2002.
- G. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

- H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.
- J. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
 - 1. Vibration Isolators: Include attachment method and rated load and deflection.
- C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
- D. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Maintenance Data: Include recommended maintenance procedures and intervals.
- H. Project Record Documents: Record actual locations of transformers.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Ambient Temperature: Do not exceed 86 degrees F average or 104 degrees F maximum measured during any 24 hour period during and after installation of transformers.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens: www.siemens.com
- E. MGM Transformers
- F. Substitutions: See Section 016000 - Product Requirements.
- G. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ALL TRANSFORMERS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: As indicated on drawings.
- C. Secondary Voltage: As indicated on drawings.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 185 degrees C insulation system with 115 degrees C average winding temperature rise.
 - 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

- E. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- F. Winding Taps:
 - 1. Less than 3 kVA: None.
 - 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
 - 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
 - 4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- G. Energy Efficiency: Standard efficiency complying with NEMA TP 1.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20.
- I. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 1.
 - b. Outdoor locations: Type 3R.
 - 2. Construction: Heavy gage steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- K. Accessories:
 - 1. Mounting Brackets: Provide manufacturer's standard brackets.
 - 2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
 - 3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.4 SOURCE QUALITY CONTROL

- A. Factory test transformers according to NEMA ST 20.
- B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install transformers in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 260534, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
- G. Mount floor-mounted transformers on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.
- H. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.
- I. Mount trapeze-mounted transformers as indicated.
- J. Provide seismic restraints.
- K. Provide grounding and bonding in accordance with Section 260526.
- L. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

- M. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.
- N. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.
- O. Identify transformers in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 014000.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.4 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262200

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SECTION 262413- SWITCHBOARDS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Switchboard.
- B. Switchboard accessories.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete for supporting foundations and pads.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 264300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

- A. NECA 400 - Standard for Installing and Maintaining Switchboards (ANSI); National Electrical Contractors Association; 2007.
- B. NEMA PB 2 - Deadfront Distribution Switchboards; National Electrical Manufacturers Association; 2011.
- C. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.
- D. Test Reports: Indicate results of factory production tests.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Project Record Documents: Record actual locations of switchboards.
- G. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Enclosure Keys: Two of each different key.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Extend existing General Electric Switchboard

2.2 SWITCHBOARDS

- A. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.
- B. Ratings:
 - 1. Voltage: 120/208 volts.
 - 2. Configuration: Three phase, four wire, grounded.
 - 3. Main Bus: See drawings.
 - 4. Integrated Equipment Rating: 65,000 rms amperes symmetrical.
- C. Main Section Devices: Individually mounted and compartmented.
- D. Distribution Section Devices: Panel mounted.
- E. Bus Material: Existing.
- F. Bus Connections: Bolted, accessible from front for maintenance.
- G. Fully insulate load side bus bars in rear accessible compartments. Do not reduce spacing of insulated bus.
- H. Ground Bus: Extend length of switchboard.
- I. Solid-State Molded Case Circuit Breakers: With electronic sensing, timing and tripping circuits for adjustable current settings; UL listed.
 - 1. Ground fault trip, ground fault sensing integral with circuit breaker.
 - 2. Instantaneous trip.
 - 3. Adjustable short time trip.
 - 4. Stationary mounting.
 - 5. Include shunt trip where indicated.
- J. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.
- K. Ground Fault Sensor: Zero sequence type.
- L. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay.1 to.5 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

M. Pull Section:

1. Arrange as shown on Drawings.

N. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

O. Enclosure: Type 1 - General Purpose.

1. Align sections at front only.
2. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.
3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
4. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard.
 - a. Use plastic strips.
 - b. Fasten strips flat against the panel face with screws or rivets.

P. Switchboard Sections.

1. Provide solid barriers between each switchboard section.

2.3 SURGE PROTECTIVE DEVICES

- A. See Section 264300 for factory-installed, internally mounted surge protective devices. List and label switchboards containing surge protective devices as a complete assembly including surge protective device.

2.4 AMMETERS AND VOLTMETERS

- A. Existing

2.5 SOURCE QUALITY CONTROL

- A. Shop inspect and test switchboard according to NEMA PB 2.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Extend existing concrete housekeeping pad under the provisions of Section 033000.

- B. Verify that field measurements are as indicated on shop drawings.

3.2 INSTALLATION

- A. Install switchboard in locations shown on drawings, according to NEMA PB 2.1.
- B. Install in a neat and workmanlike manner, as specified in NECA 400.
- C. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- D. Identify switchboards in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.4 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.
- C. Adjust circuit breaker trips and time delays in accordance with Selective Coordination Study.

3.5 CLEANING

- A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).
- F. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.
- G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.
- H. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

- I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- L. UL 67 - Panelboards; Current Edition, Including All Revisions.
- M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- N. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
- 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Field Quality Control Test Reports.

- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D Products: www.schneider-electric.us.
- B. General Electric Company: www.geindustrial.com
- C. Siemens: www.siemens.com
- D. Bussman: www.bussman.com
- E. Eaton: www.eaton.com
- F. Substitutions: See Section 016000 - Product Requirements.
- G. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ALL PANELBOARDS

- A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 1. Altitude: Less than 6,600 feet.
 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 3. Label equipment utilizing series ratings as required by NFPA 70.

- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 - 3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 - c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.
- L. Load centers are not acceptable.

M. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

D. Circuit Breakers:

1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
2. Provide thermal magnetic circuit breakers unless otherwise indicated.
3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:

1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
6. Provide the following circuit breaker types where indicated:
7. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.

10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
11. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2.6 SOURCE QUALITY CONTROL

- A. Factory test panelboards according to NEMA PB 1.

2.7 COORDINATION PANELBOARDS

- A. Bussman Quick-Spec Paanelboards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 260529.
- E. Install panelboards plumb.
- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- I. Provide grounding and bonding in accordance with Section 260526.
 - 1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
 - 2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
- J. Install all field-installed branch devices, components, and accessories.
- K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- L. Set field-adjustable circuit breaker tripping function settings as indicated.
- M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- N. Provide filler plates to cover unused spaces in panelboards.
- O. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
- P. Identify panelboards in accordance with Section 260553.
- Q. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.

3.3 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 014000.
- B. Perform field inspection and testing in accordance with Section 014000.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 225 amperes. Tests listed as optional are not required.
- E. Test shunt trips to verify proper operation.
- F. Correct deficiencies and replace damaged or defective panelboards or associated components.

- G. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

SECTION 262717 – EQUIPMENT WIRING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 26 0534 - Conduit.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 0537 - Boxes.
- D. Section 26 2818 - Enclosed Switches.

1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.5 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.

- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Wiring Devices: As specified in Section 26 2726.
- C. Flexible Conduit: As specified in Section 26 0534.
- D. Wire and Cable: As specified in Section 26 0519.
- E. Boxes: As specified in Section 26 0537.

PART 3 EXECUTION

3.1 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 262717

SECTION 262726 - WIRING DEVICES (Addendum 2)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates and covers.
- E. Floor box service fittings.
- F. Poke-through assemblies.
- G. Access floor boxes.

1.2 RELATED REQUIREMENTS

- A. Section 09 6900 - Access Flooring.
- B. Section 26 0533.16 - Boxes for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h, with Amendments (2017).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2014g, with Amendment (2017).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- L. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.
- M. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- 1.4 ADMINISTRATIVE REQUIREMENTS
- 1.5 SUBMITTALS
 - A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.6 QUALITY ASSURANCE
 - A. Comply with requirements of NFPA 70.
 - B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- 1.7 DELIVERY, STORAGE, AND PROTECTION
 - A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

- 2.1 WIRING DEVICES - GENERAL REQUIREMENTS
 - A. Provide wiring devices suitable for intended use with ratings adequate for load served.
 - B. Except where explicitly permitted, substitution of combination switch-and-receptacle devices for separate switches and receptacles is not permitted.
 - C. Wiring Device Applications:
 - 1. Receptacles Installed Outdoors or in Damp or Wet Locations: Use weather-resistant GFCI receptacles with weatherproof covers.
 - 2. Receptacles Installed in Dwelling Units: Use tamper-resistant receptacles.
 - 3. Provide GFCI protection for:
 - a. Receptacles installed within 6 feet of sinks.
 - b. Receptacles installed in kitchens.
 - c. Receptacles serving electric drinking fountains.
 - 4. Single Receptacles Installed on Individual Branch Circuits: Provide receptacle ampere rating equal to branch circuit rating.

5. Flush Floor Service Fittings in Tile Floors: Use tile rings.
6. Flush Floor Service Fittings in Carpeted Floors: Use carpet flanges.

D. Wiring Device Finishes:

1. Provide wiring device finishes as described below, unless otherwise indicated.
2. Wiring Devices, Unless Otherwise Indicated: White with _____ stainless steel wall plate.
3. Surge Protection Receptacles: Blue.
4. Wiring Devices Connected to Emergency Power: Red with stainless steel wall plate factory engraved with text "Emergency".
5. Flush Floor Box Service Fittings: White wiring devices with aluminum cover and ring/flange.
6. Flush Poke-Through Service Fittings: White wiring devices with aluminum cover and aluminum flange.
7. Access Floor Boxes: White wiring devices with gray steel cover with insert to match floor covering.

2.2 WALL SWITCHES

A. Manufacturers:

1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
2. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole

single throw, double pole single throw, three way, or four way as indicated on the drawings.

- G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
- H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.3 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
 - 2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Control: Slide control type with separate on/off switch.
- D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
- E. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.4 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
 - 3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
 - 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer.

- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 3. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 4. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.
 4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
 5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.
- E. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
 - a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
 2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A and Type C) USB charging device and receptacle, commercial

specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

- F. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.
 - 1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

2.5 WALL PLATES AND COVERS

- A. Manufacturers:
 - 1. Hubbell Incorporated; _____: www.hubbell-wiring.com/#sle.
 - 2. Intermatic, Inc; _____: www.intermatic.com/#sle.
 - 3. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
 - 4. Lutron Electronics Company, Inc; _____: www.lutron.com/#sle.
 - 5. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 6. Substitutions: See Section 01 6000 - Product Requirements.
 - 7. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer.
- B. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard; _____.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Weatherproof Receptacle Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- E. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.6 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
 - 1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - 2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 - 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Description: Service fittings compatible with floor boxes provided under Section 26 0533.16 with components, adapters, and trims required for complete installation.
- C. Above-Floor Service Fittings:

1. Single Service Pedestal Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle.
2. Single Service Pedestal Communications Outlets:
 - a. Configuration: One 1 inch bushed opening.
 - b. Voice and Data Jacks: As specified in Section 27 1005.
3. Single Service Pedestal Furniture Feed:
 - a. Configuration: One 3/4 inch knockout.
4. Dual Service Pedestal Combination Outlets:
 - a. Configuration:
 - 1) Power: One standard convenience duplex receptacle.
 - 2) Communications: One 1 inch bushed opening.
 - 3) Voice and Data Jacks: As specified in Section 27 1005.
 - b. Provide barrier to separate line and low voltage compartments.

D. Flush Floor Service Fittings:

1. Single Service Flush Convenience Receptacles:
 - a. Cover: Rectangular.
 - b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
2. Single Service Flush Communications Outlets:
 - a. Cover: Rectangular.
 - b. Configuration: _____.
 - c. Voice and Data Jacks: As specified in Section 27 1005.
3. Accessories:
 - a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
 - b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.7 POKE-THROUGH ASSEMBLIES

A. Manufacturers:

1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

- B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

C. Above-Floor Service Fittings:

1. Single Service Pedestal Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle.
2. Single Service Pedestal Communications Outlets:
 - a. Configuration: One 1 inch bushed opening.
 - b. Voice and Data Jacks: As specified in Section 27 1005.
3. Dual Service Pedestal Combination Outlets:
 - a. Configuration:

- 1) Power: One standard convenience duplex receptacle.
 - 2) Communications: One 1 inch bushed opening.
 - 3) Voice and Data Jacks: As specified in Section 27 1005.
 - b. Provide barrier to separate line and low voltage compartments.
- D. Flush Floor Service Fittings:
 1. Single Service Flush Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
 2. Single Service Flush Communications Outlets:
 - a. Configuration: _____.
 - b. Voice and Data Jacks: As specified in Section 27 1005.
 3. Dual Service Flush Combination Outlets:
 - a. Cover: Hinged door(s).
 - b. Configuration:
 - 1) Power: One standard convenience duplex receptacle(s).
 - 2) Communications: _____.
 - 3) Voice and Data Jacks: As specified in Section 27 1005.
 4. Accessories:
 - a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

2.8 ACCESS FLOOR BOXES

- A. Manufacturers - Access Floor Boxes:
 1. Hubbell Incorporated; _____: www.hubbell-wiring.com/#sle.
 2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Manufacturers - Access Floor Boxes with Pre-wired Connectors for Manufactured Wiring Systems:
 1. AFC Cable Systems Inc; _____: www.afcweb.com/#sle.
 2. RELOC Wiring Solutions, a brand of Acuity Brands, Inc; _____: www.relocwiring.com/#sle.
 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 4. Substitutions: See Section 01 6000 - Product Requirements.
 5. Source Limitations: Provide access floor boxes with pre-wired connectors produced by the same manufacturer as the manufactured wiring system used for this project.
- C. Description: Metallic multi-service box suitable for mounting in access floor system specified in Section 09 6900.
- D. Configuration:

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that core drilled holes for poke-through assemblies are in proper locations.
- H. Verify that openings in access floor are in proper locations.
- I. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Wall Dimmers: 48 inches above finished floor.
 - c. Fan Speed Controllers: 48 inches above finished floor.
 - d. Receptacles: 18 inches above finished floor or 6 inches above counter.
 - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
 - D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
 - E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
 - F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
 - G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 - H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
 - I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
 - J. Install wall switches with OFF position down.
 - K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
 - L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
 - M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
 - N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
 - O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
 - P. Identify wiring devices in accordance with Section 26 0553.
 - Q. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 262726

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SECTION 262813 - FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.2 RELATED REQUIREMENTS

- A. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 262416 - Panelboards: Fusible switches.
- C. Section 262816.16 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.
- F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.
- G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.
- H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Switches for Panelboards: See Section 262416.
 - b. Fusible Enclosed Switches: See Section 262816.16.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
 - 1. Spare Fuse Cabinet: Include dimensions.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One set(s) of three for each type and size installed.
 - 3. Fuse Pullers: One set(s) compatible with each type and size installed.
 - 4. Spare Fuse Cabinet Keys: Two.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
- B. Littelfuse, Inc; _____: www.littelfuse.com/#sle.

- C. Mersen; _____: ep-us.mersen.com/#sle.
- D. Substitutions: See Section 016000 - Product Requirements.

2.2 APPLICATIONS

- A. Service Entrance:
 - 1. Fusible Switches up to 600 Amperes: Class J, time-delay.
 - 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- B. Feeders:
 - 1. Fusible Switches up to 600 Amperes: Class J, fast-acting, non-time-delay.
 - 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- C. General Purpose Branch Circuits: Class RK1, time-delay.
- D. Individual Motor Branch Circuits: Class RK1, time-delay.
- E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.
- F. Primary Protection for Control Transformers: Class CC, time-delay.

2.3 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
 - 1. Class RK1, Time-Delay Fuses:
 - 2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:
 - 3. Class RK5, Time-Delay Fuses:
 - 4. Class RK5, Fast-Acting, Non-Time-Delay Fuses:
- H. Class J Fuses: Comply with UL 248-8.
 - 1. Class J, Time-Delay Fuses:
 - 2. Class J, Fast-Acting, Non-Time-Delay Fuses:

- I. Class L Fuses: Comply with UL 248-10.
 - 1. Class L, Time-Delay Fuses:
 - 2. Class L, Fast-Acting, Non-Time-Delay Fuses:
- J. Class T Fuses: Comply with UL 248-15.
- K. Class CC Fuses: Comply with UL 248-4.
 - 1. Class CC, Time-Delay Fuses:
 - 2. Class CC, Fast-Acting, Non-Time-Delay Fuses:
- L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- M. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.
 - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

2.4 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet in convenient location in main electrical room unless otherwise indicated.

- D. Identify spare fuse cabinet in accordance with Section 260553.

END OF SECTION 262813

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SECTION 262816.13 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
 - 1. Includes requirements for the seismic qualification of equipment specified in this section.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

- I. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- J. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Manufacturer's equipment seismic qualification certification.
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- G. Project Record Documents: Record actual installed locations of enclosed circuit breakers.
- H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE; _____: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation; _____: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc; _____: www.usa.siemens.com/#sle.
- E. Substitutions: See Section 016000 - Product Requirements.
- F. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.

- C. Seismic Qualification: Provide enclosed circuit breakers and associated components suitable for application under the seismic design criteria specified in Section 260548 where required. Include certification of compliance with submittals.
- D. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- E. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 400 amperes.
- H. Provide electronic trip circuit breakers for circuit breaker frame sizes 400 amperes and above.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
 - 3. Provide surface-mounted or flush-mounted enclosures as indicated.
- L. Provide externally operable handle with means for locking in the OFF position.
- M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - 2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.

- a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
 - c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.
- N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
- 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. 14,000 rms symmetrical amperes at 480 VAC.
 - 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - 3. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
- C. Conductor Terminations:
- 1. Provide mechanical lugs unless otherwise indicated.
 - 2. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
- 1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
- 1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

- b. Long time delay.
 - c. Short time pickup and delay.
 - d. Instantaneous pickup.
 - e. Ground fault pickup and delay where ground fault protection is indicated.
 - 2. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
 - 3. Provide communication capability where indicated: Compatible with system indicated.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- G. Provide the following circuit breaker types where indicated:
- 1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - 2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
 - 3. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
- H. Provide the following features and accessories where indicated or where required to complete installation:
- 1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).

- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed circuit breakers plumb.
- F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- H. Provide grounding and bonding in accordance with Section 260526.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 260573.
- K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- L. Identify enclosed circuit breakers in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than _____ amperes. Tests listed as optional are not required.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Test GFCI circuit breakers to verify proper operation.
- F. Test shunt trips to verify proper operation.
- G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262816.13

SECTION 263213 – ENGINE GENERATOR

PART 1 - GENERAL

1.1 SCOPE

- A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.
- B. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
- C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.2 CODES AND STANDARDS

- A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.
 - 1. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
 - 2. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 3. NFPA37 –
 - 4. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - 5. NFPA99 – Essential Electrical Systems for Health Care Facilities
 - 6. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
- B. The generator set and supplied accessories shall meet the requirements of the following standards:
 - 1. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
 - 2. UL142 – Sub-base Tanks
 - 3. UL1236 – Battery Chargers
 - 4. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

- C. The control system for the generator set shall comply with the following requirements.
1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
 2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
 3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 4. FCC Part 15, Subpart B.
 5. IEC8528 part 4. Control Systems for Generator Sets
 6. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
 7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
 8. UL1236 –Battery Chargers.
- D. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3 ACCEPTABLE MANUFACTURERS

- A. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on generator sets manufactured by MTU, Kohler, Cummins Power Generation with microprocessor-based controls. Equipment by other suppliers that meets the requirement of this specification are acceptable, if approved not less than 10 days before scheduled bid date. Proposals must include a line by line compliance statement based on this specification. Approved manufacturers include Cummins Power Generation, MTU, and Kohler.

PART 2 - PRODUCTS

2.1 GENERATOR SET

- A. Ratings (**Addendum 2**)
1. The generator set shall operate at 1800 rpm and at a voltage of 277/480 Volts AC, Three phase, 4-wire, 60 hertz.
 2. The generator shall operate on a Natural Gas fuel source and be rated at ~~150~~ **175** kW, ~~187.5~~ **218** kVA at 0.8 PF, standby rating, based on site conditions up to 3000 ft., ambient temperatures up to 104 degrees F (40 degrees C).
 3. The AC Generator shall produce 323 motor starting KVA (at 90% sustained voltage).
 4. The generator set rating shall be based on emergency/standby service.

B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The Natural Gas engine-generator set shall accept a single step load of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

- 2.2 ENGINE AND ENGINE EQUIPMENT: The engine shall be Natural Gas, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
- A. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.
 - B. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H2O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.
 - C. Electric starter(s) capable of three complete cranking cycles without overheating.
 - D. Positive displacement, mechanical, full pressure, lubrication oil pump.
 - E. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
 - F. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
 - G. Replaceable dry element air cleaner with restriction indicator.
 - H. Flexible supply and return fuel lines.
 - I. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
 - J. Coolant heater
 - 1. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system.

- The coolant heaters shall provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
2. The coolant heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
 3. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
- K. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints.
- L. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
- M. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards. The muffler and the entire run of exhaust pipe shall be wrapped with high-temp insulation.
- N. A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for each engine-generator set. The charger may be located in an automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
1. Loss of AC power - red light
 2. Low battery voltage - red light
 3. High battery voltage - red light
 4. Power ON - green light (no relay contact)
 - a. Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses.
- O. Provide level two sound attenuated weatherproof enclosure.

2.3 AC GENERATOR

- A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade.
- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- D. The subtransient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

2.4 GENERATOR SET CONTROL. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

- A. The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- B. The generator set mounted control shall include the following features and functions:
 - 1. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - 2. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
 - 3. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

4. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
- C. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:
1. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
 2. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output. Both analog and digital metering are required.
 3. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
 4. The control system shall log total number of operating hours, total KWH, and total control on hours, as well as total values since reset.
- D. Generator Set Alarm and Status Display.
1. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
 - a. The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).
 - b. The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
 - c. The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - d. The control shall include an amber common warning indication lamp.
 - e. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
 - 1) low oil pressure (warning)

- 2) low oil pressure (shutdown)
 - 3) oil pressure sender failure (warning)
 - 4) low coolant temperature (warning)
 - 5) high coolant temperature (warning)
 - 6) high coolant temperature (shutdown)
 - 7) high oil temperature (warning)
 - 8) engine temperature sender failure (warning)
 - 9) low coolant level (warning)
 - 10) fail to crank (shutdown)
 - 11) fail to start/overcrank (shutdown)
 - 12) overspeed (shutdown)
 - 13) low DC voltage (warning)
 - 14) high DC voltage (warning)
 - 15) weak battery (warning)
 - 16) low fuel-daytank (warning)
 - 17) high AC voltage (shutdown)
 - 18) low AC voltage (shutdown)
 - 19) under frequency (shutdown)
 - 20) over current (warning)
 - 21) over current (shutdown)
 - 22) short circuit (shutdown)
 - 23) over load (warning)
 - 24) emergency stop (shutdown)
 - 25) (4) configurable conditions
- f. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

E. Engine Status Monitoring.

1. The following information shall be available from a digital status panel on the generator set control:
 - a. engine oil pressure (psi or kPA)
 - b. engine coolant temperature (degrees F or C)
 - c. engine oil temperature (degrees F or C)
 - d. engine speed (rpm)
 - e. number of hours of operation (hours)
 - f. number of start attempts
 - g. battery voltage (DC volts)
 - h. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

F. Engine Control Functions.

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

G. Alternator Control Functions:

1. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

3. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.
4. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
5. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

I. Other Control Functions

1. The generator set shall be provided with a network communication module to allow LonMark compliant communication with the generator set control by remote devices. The control shall communicate all engine and alternator data, and allow starting and stopping of the generator set via the network in both test and emergency modes.
2. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

J. Control Interfaces for Remote Monitoring:

1. The control system shall provide four programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: (1) generator set operating at rated voltage and frequency, (2) common warning, (3) common shutdown, (4) load shed command.
2. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
3. A fused 10 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
4. The control shall be provided with a direct serial communication link for the LonWorks communication network interface as described elsewhere in this specification and shown on the drawings.

2.5 OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET

- A. Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.
- B. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:
- C. The generator set shall be connected to two fused disconnect switches. See the drawings for size information.

PART 3 - OPERATION

3.1 SEQUENCE OF OPERATION

- A. Generator set shall start on receipt of a start signal from ATS equipment. The start signal shall be via hardwired connection to the generator set control. The generator set shall complete a time delay start period as programmed into the control.
- B. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
- C. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.
- D. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.

- E. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- F. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous state.
- G. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
- H. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
- I. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.
- J. The Generator shall provide Load Shed Coordination with transfer switches to shed ATS#2 when the generator reaches a programmable output level prior to stalling. ATS#2 shall remain off line and automatically reset when normal power is restored.

PART 4 - OTHER REQUIREMENTS

4.1 ELECTRONIC SUBMITTALS.

- A. Within 10 days after award of contract, provide six sets of the following information for review:
 - 1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 - 2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
 - 3. Manufacturer's certification of prototype testing.
 - 4. Manufacturer's published warranty documents.
 - 5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
 - 6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
 - 7. Manufacturer's installation instructions.

4.2 FACTORY TESTING.

- A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

- B. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks' notice for testing.
- C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

4.3 INSTALLATION

- A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- D. Equipment shall be initially started and operated by representatives of the manufacturer.
- E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

4.4 ON-SITE ACCEPTANCE TEST:

- A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
- B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

- C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

4.5 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner. A video tape of the training session shall be provided with maintenance manuals for future reference by the Owner.

4.6 SERVICE AND SUPPORT

- A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

4.7 WARRANTY

- A. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.
- B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

PART 1 GENERAL

1.1 SCOPE

- A. Furnish and install automatic transfer switches (3ATS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of a mechanically held power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation. All transfer switches and control panels shall be the product of the same manufacturer.

1.2 ACCEPTABLE MANUFACTURERS

- A. Automatic transfer switches shall be ASCO Series 300 (3ATS). Any alternate shall be submitted to the consulting engineer in writing at least 10 days prior to bid. Each alternate bid must list any deviations from this specification.

1.3 CODES AND STANDARDS

- A. The automatic transfer switches and accessories shall conform to the requirements of:
 - 1. UL 1008 - Standard for Automatic Transfer Switches
 - 2. CSA C22.2 No.178 – 1978
 - 3. NFPA 70 - National Electrical Code
 - 4. NFPA 99 – Health Care Facilities
 - 5. NFPA 110 - Emergency and Standby Power Systems
 - 6. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby
 - i. Power Systems for Commercial and Industrial Applications
 - 7. NEMA Standard ICS10-2005 (formerly ICS2-447) - AC Automatic Transfer Switches
 - 8. NEC Articles 700, 701, 702
 - 9. International Standards Organization ISO 9001: 2008
 - 10. IEC 60947 – 6 – 1

PART 2 PRODUCTS

2.1 ATS INFO

- A. Life safety Non-automatic transfer switch – 200A – 480V – Nema 1 enclosure
- B. Life safety Automatic transfer switch – Open Transition – 200A – 480V – Nema 1 enclosure
- C. Equipment Non-automatic Transfer switch – 400A – 480V – Nema 1 enclosure

- D. Equipment Automatic transfer switch – Delayed transition - 400A – 480V – Nema 1 enclosure
- E. 5350 annunciator
- F. 5101-Gen Kit – Start signal monitoring
- G. Approved Manufacturers - Cummins

2.2 ATS ACCESSORIES

- A. 6DL Description (NTS only): Retransfer to normal mode. While in manual retransfer mode if an emergency source failure should occur and the normal source is still available manual retransfer will be automatically bypassed. A pilot light indicates manual retransfer mode.
- B. 7ES Description : 5101 Engine Start Circuit Monitor. 5101-ATS module pre-wired to the Feature 7 NC Start Signal ready for integration into a engine start monitoring system. (Must be wired to 5101-GEN module at generator)
- C. 11BE Description : Adds the following features to the Group G controller: (1) Serial RS-485 Modbus Communications (2) Multi-Schedule Engine Exerciser (3) a 300 Entry Event Log and (4) a common alarm output function. When applied on 3-phase systems it also enables: (1) 3-Phase Emergency Source VLL sensing (2) Phase Rotation Monitoring (3) Emergency Source VLL Unbalance Monitoring.
- D. 18RX Description : REX (Relay Expansion Module) with Normal and Emergency available output contacts (18B & 18G)
- E. 30AA Description (Delayed Transition ONLY): Load shedding circuit initiated by opening of a customer - supplied contact
- F. 72EE Description : Quad - Ethernet Module with AES - 128 bit with encryption and (4) RJ - 45s, includes 11BE feature bundle
- G. 135L Description : Power Meter on Load Side with CT

2.3 MECHANICALLY HELD TRANSFER SWITCH

- A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include over current disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.
- B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

- C. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.
- D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.
- E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- F. Where neutral conductors must be switched, the ATS shall be provided with fully- rated neutral transfer contacts.
- G. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.4 GROUP 'G' CONTROLLER WITH INTEGRATED USER INTERFACE PANEL

- A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via the Ethernet through optional communications module
- C. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.1\text{Hz}$. Time delay settings shall be accurate to $\pm 0.5\%$ of the full scale value of the time delay. The panel shall be capable of operating over a temperature range of -20 to + 70 degrees C, and storage from -55 to + 85 degrees C.
- D. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. IEC 60947 – 6 – 1 Multiple Function Equipment Transfer Switching Equipment.
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- a. IEC 61000 – 4 - 2 Electrostatic Discharge Immunity
 - b. IEC 61000 – 4 - 3 Radiated RF Field Immunity
 - c. IEC 61000 – 4 - 4 Electrical Fast Transient/Burst Immunity
 - d. IEC 61000 – 4 - 5 Surge Immunity
 - e. IEC 61000 – 4 – 6 Conducted RF Immunity
2. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions

2.5 ENCLOSURE

- A. The 3ATS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.
- B. Provide strip heater with thermostat for Type 3R enclosure requirements.
- C. Controller shall be mounted on, visible, and operational through enclosure door.

PART 3 OPERATIONS

3.1 CONTROLLER DISPLAY AND KEYPAD

- A. A 128*64 graphical LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through communications port. The following parameters shall only be adjustable via DIP switches on the controller.
 - 1. Nominal line voltage and frequency
 - 2. Single or three phase sensing on normal
 - 3. Transfer operating mode configuration, (open transition, or delayed transition)
- B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.2 VOLTAGE AND FREQUENCY SENSING

- A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup ,dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified).

<u>Parameter</u>	<u>Sources</u>	<u>Dropout/Trip</u>	<u>Pickup/Reset</u>
Undervoltage	N & E	70 to 98%	85 to 100%
Overvoltage	N & E	102 to 116%	2% below trip
Underfrequency	N & E	85 to 98%	86 to 100%
Overfrequency	N & E	101 to 111%	2% below trip

- B. Repetitive accuracy of all settings shall be within 1% at +25C
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- D. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage and frequency. *Note: Single phase sensing on emergency*
- E. The backlit 128*64 graphical display shall have multiple language capability. Languages can be selected from the user interface.

3.3 TIME DELAYS

- A. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds. It shall be possible to bypass the time delay from the controller user interface.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface.
- C. A generator stabilization time delay shall be provided after transfer to emergency adjustable 0 or 4 seconds.
- D. A time delay shall be provided on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.
- E. A cooldown time delay shall be provided on shutdown of engine generator, Adjustable 0 to 60 minutes 59 seconds.
- F. All adjustable time delays shall be field adjustable without the use of special tools.
- G. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes 59 seconds time delay in any of the following modes:
 - 1. Prior to transfer only.
 - 2. Prior to and after transfer.
 - 3. Normal to emergency only.
 - 4. Emergency to normal only.
 - 5. Normal to emergency and emergency to normal.

- 6. All transfer conditions or only when both sources are available.
- H. In the event that the alternate source is not accepted within the configured Failure to Accept time delay, the common alert indication shall become active.
- I. The controller shall also include the following built-in time delay for delayed transition operation.
 - 1. A time delay for the load disconnect position for delayed transition operation adjustable 0 to 5 minutes 59 seconds.

3.4 ADDITIONAL FEATURES

- A. The user interface shall be provided with test/reset modes. The test mode will simulate a normal source failure. The reset mode shall bypass the time delays on either transfer to emergency or retransfer to normal.
- B. A set of contacts rated 5 amps, 30 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down. setting, regardless of whether the normal source restores before the load is transferred.
- C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed when the ATS is connected to the emergency source.
- D. A single alarm indication shall light up the alert indicator and de – energize the configured common alarm output relay for external monitoring.
- E. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- F. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.
- G. LED indicating light shall be provided to indicate switch not in automatic mode (manual); and blinking (amber) to indicate transfer inhibit.
- H. LED indicating light shall be provided to indicate any alarm condition or active time delay (red).
- I. *The following features shall be built – in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:*
 - I. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

- J. A variable window inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO feature 27.
- K. An engine generator exercising timer shall be provided to configure weekly and bi-weekly automatic testing of an engine generator set with or without load for 20 minutes fixed. It shall be capable of being configured to indicate a day of the week, and time weekly testing should occur.

The following feature shall be built – into the controller, but capable of being activated through keypad programming, communications interface port, or additional hardware.

- L. Terminals shall be provided for a remote contact to signal the ATS to transfer to emergency. This inhibit signal can be enabled through the keypad or serial port.
- M. System Status - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key. This screen shall display a clear description of the active operating sequences and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Emerg
2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual are not permissible.

- N. Self Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- O. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication port with a network of transfer switches, locally (up to 4000 ft.). Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control, and setup of parameters.
- P. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non – volatile memory.
 - 1. Event Logging
 - a. Data and time and reason for transfer normal to emergency
 - b. Data and time and reason for transfer emergency to normal

- b. Data and time and reason for engine start
- c. Data and time engine stopped
- d. Data and time emergency source available
- e. Data and time emergency source not available

2. Statistical Data

- a. Total number of transfers
- b. Total number of transfers due to source failure
- b. Total number of day's controller is energized
- c. Total number of hours both normal and emergency sources are
 - 1. Available
- d. Total time load is connected to normal
- e. Total time load is connected to emergency
- f. Last engine start
- g. Last engine start up time
- h. Input and output status

4.1 OPTIONAL FEATURES *(The following section is optional and should be deleted if not required)*

A. Accessory Package - An accessory bundle shall be provided that includes:

- 1. A fully programmable engine exerciser with seven independent routines to exercise the engine generator, with or without load on a daily weekly, bi – weekly, or monthly basis.
- 2. Event log display that shows event number, time and date of events, event type, and reason (if applicable). A minimum of 300 events shall be stored.
- 3. RS – 485 communications port enabled.
- 4. Common alarm output contact.

(This feature shall be equal to ASCO accessory 11BE, and shall be capable of being activated for existing switches through optional accessory dongle).

B. Controller Power Supply - A backup power UPS shall be provided to allow controller to run for 3 minutes minimum without AC power. (This feature shall be equal to ASCO accessory 1UP, and shall be capable of being added to existing switches without modification).

C. Expansion Module - A relay expansion module (REX) is a standard feature when delayed transition transfer is specified. A REX module shall also be provided for open transition transfer that includes one form C contact for source availability of the normal (18G) and emergency (18B) sources. Additional output relay shall be provided to indicate a common alarm. The REX module shall have the capability of being daisy chained for multiple sets of contacts. (This feature shall be equal to ASCO accessory 18RX, and shall be capable of being added to existing switches without modification).

- D. Current Sensing Card - A load current metering card shall be provided that measures either single or three phase load current. It shall include current transformers (CT's) and shorting block. Parameters shall be able to be viewed via the user interface. (This feature shall be equal to ASCO accessory 23GA (single phase), 23GB (three phase), and shall be capable of being added to existing switches without modification).
- E. Communications Module – Shall provide remote interface module to support monitoring of vendor's transfer switch, controller and optional power meter. Module shall provide status, analog parameters, event logs, equipment settings & configurations over embedded webpage and open protocol. Features shall include:
1. Email notifications and SNMP traps of selectable events and alarms may be sent to a mobile device or PC.
 2. Modbus TCP/IP, SNMP, HTTP, SMTP open protocols shall be simultaneously supported.
 3. Web app interface requiring user credentials to monitor and control the transfer switch supporting modern smart phones, tablets and PC browsers. User will be able to view the dynamic one-line, ATS controls status, alarms, metering, event logging as well as settings.
 4. Secure access shall be provided by requiring credentials for a minimum of 3 user privilege levels to the web app, monitor (view only), control (view and control) and administrator (view, control and change settings). 128-Bit AES encryption standard shall be supported for all means of connectivity.
 5. Shall allow for the initiating of transfers, retransfers, bypassing of active timers and the activating/deactivating of engine start signal shall be available over the embedded webpage and to the transfer switch vendor's monitoring equipment.
 6. An event log displaying a minimum of three-hundred (300) events shall be viewable and printable from the embedded webpages and accessible from supported open protocols.
 7. Four (4) 100 Mbps Ethernet copper RJ-45 ports, two (2) serial ports, and LEDs for diagnostics.
 8. DIN rail mountable.

This option shall be equivalent to ASCO accessory 72EE

**Note Spec Writer:* The following section is optional and should be deleted if not required.

- I. Power Meter – (This feature shall be equal to ASCO accessory 135L)

The Power Meter shall conform to the requirements of:

1. UL 3111-1-Electrical Measuring and Testing Equipment
2. CAN/CSA-C22.2 No. 23-M89-CSA Safety Requirements for Electrical and Electronic Measuring and Test Equipment
3. The Power Meter shall be capable of operating without modification at a nominal frequency of 45 to 66Hz.
4. The Power Meter shall be rated for an operating temperature of -4°F to 158°F and a storage temperature of -22°F to 176°F. and shall be rated for an 85% non-condensing, relative humidity.

5. The Power Meter shall accept inputs from industry standard instrument transformers (120 VAC secondary PT's and 5A secondary CT's). Direct phase voltage connections, 0 to 600VAC nominal, shall be possible without the use of PT's.
6. The Power Meter shall accept single, 3 phase, or three & four wire circuits. A fourth CT input shall be available to measure neutral or ground current.
7. The Power Meter shall contain a built-in discrete contact to wire an ATS 14A auxiliary contact to indicate switch position.
8. The Power Meter shall accept AC voltage from the sensing lines for operation. Additional provisions shall be provided for external DC voltage input range 9-36 VDC with a nominal of 24 VDC.
9. The Power Meter shall be equipped with a continuous duty, long –life, 4 line x 20 character green backlit LCD
10. All setup parameters required by the Power Meter shall be stored in non-volatile memory and retained in the event of a control power interruption.
11. The Power Meter shall be flush mountable on a surface.
12. The Power Meter enclosure shall be sealed to IP-51 (NEMA 1) and the faceplate shall be sealed to IP-65 (NEMA 4). All push buttons shall be sealed tact switches.
13. The Power Meter shall send, when prompted, information to a central location equipped with a manufacturer supplied critical power management system or 3rd party monitor through manufacturer supplied communication modules. All 3rd party monitor must utilize industry standard open protocols Modbus/RTU.Modbus/TCP or SNMP.
14. An embedded RS-485 port will be provided which will enable communication at 9600, 19.2K, 38.4K, or 57.6K baud. DIP switches will be provided on the RS-485 port allowing a user to select 2-wire or 4-wire communication as well as the option to activate a terminating resistor on the port.
15. The Power Meter shall help facilities comply with NEC 220. It shall provide Maximum Demand calculations for the past 24 months, as per standards with 15 minute averages.
16. The following data will be available on the display and Modbus registers of the Power Meter:
 - *Line-to-neutral voltages (V_{AN} , V_{BN} , and V_{CN})*
 - *Line-to-neutral voltage average (V_{AVE})*
 - *Line-to-line voltages (V_{AB} , V_{BC} , and V_{CA})*
 - *Line-Line voltage average (V_{LAVE})*
 - *Current on each phase (I_A , I_B , and I_C)*
 - *Current on the neutral conductor (I_N)*
 - *Average current (I_{AVE})*
 - *Active power, KW per phase and total (W_A , W_B , W_C , and W_T)*
 - *Apparent power, KVA per phase and total (V_{AA} , V_{AB} , V_{AC} , and V_{AT})*

 - *KWHours importing, exporting and net (KWH_{IMP} , KWH_{EXP} , and KWH_{NET})*

- *KVARHours leading, lagging and net (KVARH_{LEAD}, KVARLAG, and KVARHNET)*
 - *Power factor (PF)*
 - *Signal Frequency (Hz)*
 - *Digital Input*
17. The Power Meter shall offer an LCD which can display no less than nine different languages.
 18. Displaying each of the metered values shall be done through the use of menu scroll buttons. There will be an escape button which will be used to take the user back to the previous page or to cancel a setting change. Pressing escape no more than three times will return the user to the home screen.
 19. For ease of operator viewing, the display can be configured to remain on continuously, with no detrimental effect on the life of the Power Meter.
 20. The display's contrast shall be configurable in intervals of 10% (ranging 0%-100%).
 21. Setup of a system requirements shall be allowed from the front of the Power Meter.

**Note Spec Writer: The following section is optional and should be deleted if not required.*

5.1 ATS REMOTE ANNUNCIATOR

General

Provide and install ATS Remote Annunciators for monitoring and control of automatic transfer switches remotely over Ethernet.

A. Hardware Specifications

The ATS Remote Annunciator shall be listed to cUL-60950-1 and UL 1008 and include the following features and ratings:

- *User-configured labels with ATS names and power sources*
- *Dual 10/100 Base-T auto sensing and auto crossover Ethernet ports*
- *LED indication of source acceptability, switch position, common alarm, time delay and Ethernet link activity*
- *Push button for transfer/retransfer control operations and time delay bypass*
- *Push buttons for Alarm Silence and Lamp Test*
- *Key lock to enable and disable the transfer push button*
- *Audible and visual alarm to indicate Communication Error ATS Locked Out Failure to Synchronize Extended Parallel and any of the 8 user-configured discrete inputs*
- *Programmable watchdog timer that can generate a system reset upon timeout (minimum 1 sec)*
- *Factory reset capability*
- *100 ms power ride-through*

B. Software Specification

The ATS Remote Annunciator shall contain embedded web pages accessible via various web browsers with the following capabilities:

- *Configuration for protocol and communications management with the ability of auto discovering transfer switches on network*
- *Ability to create and print customized labels for ATS names and power sources*
- *The ability to choose a continuous or periodic audible alarm with customizable interval time*
- *View detailed packet status counters i.e. transmitted received and dropped packets with the ability to reset counters*
- *ATS source name configuration page which allows users to configure power source names and print labels*
- *Upgrade firmware from Ethernet network without interrupting equipment operation*

C. Communications

Dual 10/100 Base-T (RJ-45) Ethernet ports are provided to support TCP/IP communications for up to eight automatic transfer switches via individual remote connectivity modules or daisy-chained serial modules into a single Connectivity Module. Additional features include:

- *Supports Full Duplex Flow Control (IEEE 802.3x)*
- *3.3V power supply with 5V I/O tolerance*
- *Supports 3 LEDs to indicate traffic link speed and collision*

D. Mounting

The ATS Remote Annunciator is suitable for:

- *Surface mounting using mounting screws studs*
- *Flush Mount from behind a cutout section (Enclosure Door Mounting)*
- *Flush Mount from the front of a cutout section (Enclosure Door Mounting)*

E. Power Supply

The ATS Remote Annunciator shall be capable of accepting 24VDC, 120 VAC or 240 VAC power source.

F. Environmental

The ATS Remote Annunciator shall have an Ambient Operating Temperature range of -4 ° to 158 ° F (-20 ° to +70 ° C) @ 5~85% humidity and Ambient Storage Temperature of -40 ° to 185 ° F (-40 ° to 85 ° C).

PART 6 ADDITIONAL REQUIREMENTS

6.1 WITHSTAND AND CLOSING RATINGS

- A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on

the plans. WCR ATS ratings shall be as follows when used with specific circuit breakers:

ATS Size	Withstand & Closing Rating MCCB (480v/60hz)	W/CLF
30	22,000A	100,000
70 - 200	22,000A	200,000
230	25,000A	100,000
260 – 400	42,000A	200,000
600	50,000A	200,000
800 – 1200	65,000A	200,000
1600 – 2000	85,000A	200,000
2600 – 3000	100,000A	200,000

6.2 TESTS AND CERTIFICATION

- A. The complete 3ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The ATS manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2008.

6.3 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of switch shipments, by serial number, for a minimum of 20 years.
- C. For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.

END OF SECTION 263600

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SECTION 264300 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surge protective devices for service entrance locations.
- B. Surge protective devices for distribution locations.
- C. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 262413 - Switchboards.
- C. Section 262416 - Panelboards.
- D. Section 271000 - Structured Cabling: Protectors for communications service entrance.

1.3 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

- A. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2014).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

- G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.6 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
 - 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
- D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 - 1. UL 1449.
 - 2. UL 1283 (for Type 2 SPDs).
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.7 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.9 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum ten year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
- C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Schneider Electric
- B. Field-installed, Externally Mounted Surge Protective Devices - Other Acceptable Manufacturers:
 - 1. Advanced Protection Technologies (APT)
 - 2. ASCO Power Technologies
 - 3. Leviton
 - 4. Surge Suppression Incorporated (SSI)
- C. Factory-installed, Internally Mounted Surge Protective Devices:
 - 1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

- D. Substitutions: See Section 016000 - Product Requirements.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
- C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- D. Protected Modes:
1. Wye Systems: L-N, L-G, N-G, L-L.
- E. UL 1449 Voltage Protection Ratings (VPRs):
1. 208Y/120V System Voltage: Not more than 800V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
 2. 480Y/277V System Voltage: Not more than 1,200 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.
- F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
1. Indoor clean, dry locations: NEMA Type 1.
 2. Outdoor locations: NEMA Type 3R.
- H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
 2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.
- I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
1. Switchgear: See Section 262300.
 2. Switchboards: See Section 262413.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
(EMA Series) Model: SSPxxEMA24
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
6. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
 - d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.4 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards, motor control centers, and busway.

B. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
(EMA Series) Model: SSPxxEMA16
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - a. Noise Attenuation: Not less than -50 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.

- b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
 - d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.5 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:

- 1. Protection Circuits: Field-replaceable modular or non-modular.
- 2. Surge Current Rating: Not less than 50 kA per mode/100 kA per phase.
(XDSE Series) Model: SSPxxXDSE10A
- 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
- 5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
- 6. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

- D. Verify system grounding and bonding is in accordance with Section 260526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- C. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 260526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.
- G. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS Section 7.19.1.
- D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.4 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 264300

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Interior luminaires.
- B. Lamps.
- C. Luminaire accessories.

1.2 RELATED REQUIREMENTS

- A. Section 260537 - Boxes.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 260923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- D. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.
- E. Section 265200 – Gymnasium Theatrical Lighting.

1.3 REFERENCE STANDARDS

- A. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type); 2002.
- B. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; Consolidated-2002.
- C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (R2008).
- D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002.
- E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.
- F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

- G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.
- H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2006.
- I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.
- K. UL 1029 - High-Intensity-Discharge Lamp Ballasts; Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
- 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
- 3. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:

- 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
 2. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
- D. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.
- E. Field Quality Control Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
 2. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type. Exclude LED lamps from this section.
 3. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type. Do not include LED Drivers.
- I. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Conform to requirements of NFPA 70 and NFPA 101.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for all linear fluorescent ballasts.
- C. Provide five year pro-rata warranty for batteries for emergency lighting units.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires: Listed and labeled as complying with UL 8750.

1. Provide lumen output and color temperature as indicated on the Luminaire schedule.
2. Provide LED driver as indicated on the Luminaire schedule. Provide 0-10v dimming driver where required.
3. LED Luminaires shall be warranted for a minimum of 10 years.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.

- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members, or to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- F. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- G. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.
 - 5. Unless otherwise indicated, support pendants from swivel hangers.
- H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.

- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265100

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SECTION 265600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires.
- B. Poles and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0537 - Boxes.
- E. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including outdoor motion sensors, time switches, and outdoor photo controls.
- F. Section 26 2726 - Wiring Devices: Receptacles for installation in poles.

1.3 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code; 2017.
- B. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.

- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
 - 3. Provide structural calculations for each pole proposed for substitution.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
- D. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
- E. Field Quality Control Reports.
 - 1. Include test report indicating measured illumination levels.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

- H. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.

- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.

- D. Install luminaires in accordance with NECA/IESNA 501.
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Install accessories furnished with each luminaire.
- H. Bond products and metal accessories to branch circuit equipment grounding conductor.
- I. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.
- E. Measure illumination levels at night with calibrated meters to verify compliance with performance requirements. Record test results in written report to be included with submittals.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

3.6 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

3.9 ATTACHMENTS

- A. Luminaire schedule.

END OF SECTION 265600

SECTION 26 6000 – CAFETERIA / GYM THEATRICAL LIGHTING SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The Electrical Contractor, as part of this section, shall provide, install and test a theatrical lighting system as specified herein for areas indicated on the drawings.
- B. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the theatrical lighting system.
- C. The Electrical Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to:
 - 1. General conditions
 - 2. Electrical section general provisions
 - 3. Conduit
 - 4. Wire and Cable
- D. The systems shall be designed for the control of theatrical lighting systems and shall consist of factory pre-wired dimming, rack enclosures, power supplies, breakers, terminals and/or control electronics and electric hoist system.

1.2 SUBMITTALS

- A. Manufacturer shall provide shop drawing submittals. Refer to Division 1 for quantity of submittals and shop drawings. Submittals shall include:
 - 1. Manufacturer shall provide shop drawing submittals. Refer to Division 1 for quantity of submittals and shop drawings. Submittals shall include:
 - 2. Full set of printed technical data sheets.
 - 3. Detailed set of schedules.

- 4. Detailed set of circuit and control schedules, including a complete list of all deviations from the specifications.
- B. Product data for video equipment, lighting fixtures, lamps, distribution components, and control systems, including dimensions and data on features and components. Include data on ratings and features of devices.
- C. Manufacturer Certificates: Signed by manufacturers certifying that they comply with the requirements. Include evidence of manufacturing experience.
- D. Field test reports: Indicate and interpret test results for compliance with performance requirements.
- E. Manufacturer shall provide and additional information, including equipment demonstration, as required by the Engineer to verify compliance with the specifications.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 "National Electrical Code" for components and installation.
- B. Installer Qualifications: An experienced installer who has installed systems of similar scope and function as the required for this project.
- C. Manufacturer shall be one who has been continuously engaged in the manufacturing of lighting control equipment for a minimum of ten years.
- D. Proposed equipment shall be UL and C-UL listed, and/or CE marked (where applicable) and bear the appropriate labels.
- E. All dimmers, enclosures, controls, and fixtures shall be manufactured in the United States. Equipment manufactured outside of the United States will not be accepted.

1.4 QUALIFICATIONS OF BIDDERS

- A. The bidder shall be a firm with a minimum of 5 years of experience in the fabrication, assembly, and installation of audio systems of similar magnitude and quality as specified in these documents, and shall submit documentation to this effect with the bid return.
- B. The bidder shall be I.C.I.A / A.V.S.P certified.

1.5 ALTERNATE EQUIPMENT

- A. This equipment was selected to establish a standard of quality and performance. The contractor may offer substitutes for approval but the burden of proof of equality shall be with the contractor.
- B. Pre-approval submittals shall contain a component-by-component comparison of all specification lines. Differences shall be clearly high-lighted with the explanation and support data. Connection drawings shall also be provided to establish how the substituted components will achieve the specified system design
- C. The contractor shall provide any additional documentation, samples, or performance tests required by the Engineer in order to establish proof of equality with the specified equipment.
- D. All substitutions shall provide equal or greater system performance and function. No substitute equipment shall be purchased or installed without approval by the Engineer.
- E. Final approval of the substituted equipment shall be given after the system has been installed. Failure to meet the specification, as determined by the Engineer, shall result in the removal of the substituted equipment and the installation of the specified equipment without any additional cost to the owner.

1.5 EXCEPTIONS

- A. Any and all exceptions to these specifications and related drawings must be made with the submission of the bid. In the absence of exceptions, the specifications and related drawings shall be binding in letter and intent on the successful bidder. It will also be understood that the bidder has examined the design and specifications in detail, and is prepared to take full responsibility for the performance of the complete installation as designed and specified.

1.6 SUB-CONTRACT INFORMATION

- A. Any and all sub-contractors that a bidder plans to utilize for this project are to be listed with the references and qualifications in the bid submission. The successful bidder shall supervise all sub-contract work. Any and all sub-contract work is the complete and sole responsibility of the contractor.

1.7 SPECIFICATION INFORMATION REQUESTS AND QUESTIONS

- A. Any requests for clarification shall be submitted to Mr. DJ Seibert of Snyder Hoffman Associates, 1005 West Lehigh Street, Bethlehem, PA, 18018, 610-694-8020,

dseibert@snyderhoffman.com. All requests are to be made in writing and submitted no later than ten days prior to bid submission.

1.8 CERTIFICATIONS AND REPRESENTATIONS

- A. Quality of materials: All equipment items and installation materials will be new. No previously owned, demonstrated or otherwise used items will be provided. Note that prior to equipment installation and on-site integration, all equipment items shall be performance tested and quality checked to insure full functionality of each equipment item.
- B. Tax Statement Certification: The contractor certifies that all local, state, and federal taxes are separately listed in any price quotations.

1.9 ACCEPTABLE MANUFACTURERS

- A. The lighting equipment shall be manufactured by:

- 1. Electronic Theater Controls
630 9th Ave Suite 1001
New York, NY 10036
Phone: 1-212-397-8080
Fax: 1-212-397-4340
Web: www.etcconnect.com

- B. Alternative Manufacturers: Subject to compliance with requirements, manufactures offering products that may be incorporated into the work include, but not limited to, the following:

- 1. Lehigh Electric Products Company
6265 Hamilton Blvd
Allentown, PA 18106
Phone: 610-395-3386
Fax: 610-395-7735
Web: www.lehighdim.com
- 2. Altman Lighting, Inc.
57 Alexander Street
Yonkers, NY 10701
Phone: 914-476-7987
Fax: 914-963-7304
Web: www.altmanltg.com

3. Strand Lighting, Inc.
928 Broadway, Suite 1010
New York, NY 10010
Phone: 212-242-1042
Fax: 212-242-1837
Web: www.strandlighting.com
- C. Permission to bid does not imply acceptance of the manufacturer. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for control systems that meet or exceed the specifications.
- D. Other manufacturers wishing to be considered for prior approval must submit the following items prior to the bid date. Approval to bid does not waive the requirement to comply with the equipment specifications listed in this section.
 1. C A complete bill of material listing all proposed equipment.
 2. Catalog sheets detailing the products proposed in 1 above.
 3. Description listing any deviations the proposed substitution has as compared with the specified system.
 4. Detail additional costs associated with using the alternate system in lieu of the specified system.
- E. Alternative manufacturers must submit a full pre-approval package no later than ten days prior to bid date.
- F. Permission to bid does not imply acceptance of the manufacturer. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for control systems that meet or exceed the specifications.
- G. The manufacturer's latest published equipment specifications shall be considered as part of this text.

PART 2 PRODUCTS

2.1 FIXTURES AND DISTRIBUTION EQUIPMENT, GENERAL

- A. Metal Parts: Free from burrs and sharp corners and edges.

- B. Sheet metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Fixture doors and other internal access: Smooth operating, free from light leakage, and arranged to permit relamping without the use of tools. Arrange doors, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when in operating position.
- D. Pigtail: Factory wired, 36 inch (900mm) long, 3-wired cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.
- E. Plug Connectors: Two-pole, 3 wire, 20A Edison type.
- F. Safety Cables: Heavy duty, flexible steel, 30 inch nominal length, with spring clip at one end and steel ring at other.
- G. Pipe Clamps: Malleable iron, suitable for clamping fixtures or items to pipe from 3/4" to 2 inch in outside diameter. Arrange fixture clamps for horizontal rotation of yoke for aiming and equipped with a T-bolt to lock alignment.
- H. Fixture Operating Controls and Handles: Thermally Insulated.
- I. Fixture Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

2.2 INTELLIGENT BREAKER SYSTEM

A. General

- 1. Intelligent breaker system shall be 120V Sensor IQ as manufactured by ETC, Inc., or equal
- 2. Breaker Panels shall be UL508, UL67, and UL924 Listed, and shall be so labeled when delivered
- 3. Breakers shall be UL489 listed and shall be labeled when delivered
- 4. Breaker Panels shall consist of a main enclosure with 12, 24, or 48 pole breaker subpanels, integral control electronics for low voltage terminations and provision for accessory cards
 - a. Up to two accessory cards shall be supported per breaker panel

B. Mechanical

1. The panel shall be constructed of 16-gauge galvanized steel. All panel components shall be properly treated or finished in fine-textured, scratch resistant paint
2. Breaker panels shall be capable of being mounted on the surface of a wall or recessed mounted
3. Breaker panels shall be available in 12, 24, and 48 pole configurations.
4. Choice of panel covers shall be available for surface or recess mount applications. This outer panel shall ship complete with a locking door to limit access to electronics and breakers
 - a. Optional center-pin reject security screws shall be available for all accessible screws
 - b. Optional recess mount doors shall extend 1" beyond all panel edges to hide wall cut-out
5. The unit shall provide interior cover over the control electronics and accessory cards to allow access only to class 2 wiring and prevent direct access to class 1 line voltage components
6. The panel shall support up to twelve, twenty-four, or 48 single pole branch circuits
 - a. Branch circuits shall range from 15A to 30A capable of holding full rated load for minimum of three hours continuously
 - b. Two and three-pole circuits shall be supported at decreased density where each pole constitutes one of the available single-pole circuits. Mixing of circuits in any combination shall be supported
7. Breakers shall provide manual switching control while power is unavailable to the panel such that critical lighting can be set to an on state, without the need for power to the panel
8. Breaker output lugs shall accept 10-14 AWG dual conductor wire
9. Breaker output lug shall support solid or stranded 6-14 AWG class B, C, or K copper wire

10. Control wiring for DMX, station bus, and Emergency input terminations shall land on a removable headers for contractor installation

C. User Interface

1. The user interface shall contain an LCD display with button pad to include 0-9 number entry, up, down back arrow navigation and enter
2. Test shortcut button shall be available for local activation of preset, sequence and set level overrides
3. The user interface shall have a power status LED indicator (Blue), a DMX status LED indicator (Green), a network status LED indicator (Green) and an LED indicator (red) for errors
4. Interface shall allow the backlight to timeout and shall provide user editable options to shut off backlight completely as well as adjust screen contrast
5. Ethernet interface shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible
6. The control interface shall support a USB memory stick interface for uploads of configurations and software updates
7. The user interface shall support power input from an external Uninterruptible Power Supply (UPS) supplying 800W-2400W AC power

D. Functional

1. Panel setup shall be user programmable. The control interface shall provide the following breaker setup features (per circuit):
 - a. Type (1 pole, 2 pole, or 3 pole)
 - b. Name
 - c. Circuit Number
 - d. DMX address
 - e. sACN address

- f. Space Number
 - g. Circuit Modes
 - i. Normal (priority and HTP based activation and dimming)
 - ii. Latch-lock
 - iii. Fluorescent
 - iv. DALI
 - a. On threshold level
 - b. Off threshold level
 - c. Include in UL924 emergency activation
 - d. Allow Manual
2. Breaker panels shall support discrete addressing of each breaker. Panels that are restricted to use of start address with sequential addressing, and cannot assign each 0-10V output control to any internal circuit shall not be acceptable
3. The panel shall be capable of switching 6 poles on or off at once, or in a user-selectable delay per breaker using a period of 0.1 to 60 seconds, in 0.1 second increments
4. An Ethernet connection shall provide advanced control of relays over streaming ACN (sACN) and transmit status, control override, and measured energy usage per branch circuit via an internal Web UI or central monitoring interface
- a. Control electronics shall report the following information per branch circuit.
 - i. Breaker state (On/Off)
 - ii. Breaker state (Open/Closed)
 - iii. Current draw (In Amps)

- iv. Voltage
 - v. Energy usage
 - b. Panels that do not report this information shall not be acceptable.
5. Built-in Control shall include:
- a. Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events
 - b. Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting breaker state on each breaker, or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space
 - c. Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet
 - d. Indication of an active preset shall be visible on the control panel display
 - e. One 16-step sequence per space for power up and power down routines
 - f. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting included breakers to “on”, while setting non-emergency breakers “off”. Each breaker can be selected for activation upon contact input
 - g. Upon Data loss the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority
 - h. Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable
 - i. After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets,

sequences and zones, or local overrides) is received to make each breaker change state

6. The control of lighting and associated systems via timed and Astronomical clock controls
 - a. The breaker panel shall allow the activation of presets, sequence, and zone programming of up to 50 time clock events via a built in real and astronomical time clock
 - b. System time events shall be programmable via the control panel
 - i. Time clock events shall be assigned to system day types. Standard day types include: everyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday
 - ii. Time clock events shall be activated based on sunrise, sunset, time of day or periodic event
 - iii. System shall automatically compensate for regions using a fully configurable daylight saving time
 - iv. Presets shall be assigned to events at the time clock
 - c. The time clock shall support event override
 - i. It shall be possible to override the timed event schedule from the face panel of the time clock
 - d. The time clock shall support timed event hold
 - i. It shall be possible to hold a timed event from the face panel of the processor
 - ii. Timed event hold shall meet California Title 24 requirements
7. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad with any circuit patched to any DMX control address

- a. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components
 - b. The breakers shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz
 - c. Setting changes shall be able to be made across all, some, or just one selected breaker in a single action from the face panel
 - d. DMX data loss shall allow for levels/breakers to be held for ever or for a specified time before switching to a lower priority source
- E. Initial Panel setup
1. The breaker panel shall automatically detect the type of breaker or dimmer installed in each location without need for manual configuration of the physical arrangement
 2. Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address
 3. Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting

PART 3 FIXTURES

3.0 THEATRICAL LIGHTING FIXTURES

A. LED Wash Fixtures

1. Colour mixing Light Emitting Diode Wash fixture
2. General
 - a. The fixture shall be a colour-mixing high-intensity LED illuminator with DMX control of intensity and colour. The fixture shall be a ColorSource PAR or approved equal.
 - b. All LED fixtures shall be provided by a single manufacturer to ensure compatibility
 - c. The fixture shall be CE compliant and UL 1573 listed for stage and studio use
 - d. The fixture shall comply with the USITT DMX512-A standard
 - e. The fixture shall be provided with the minimum warranty of 5 years full fixture coverage and 10 years LED array coverage

- f. ColorSource PAR and ColorSource PAR Deep Blue
- g. The fixture shall have a LM-84 report with a L70 rating of no less than 55,000 hours
 - i. Substitutes must provide evidence of minimum L70 rating of no less than 55,000 hours
 - 1) If no LM-84 report is available, an acceptable alternate is a LM-80 report on all emitters with a LM-79 report and an in situ temperature measurement test verifying the conditions of the fixture meet the conditions of the LM-80 report
 - 2) All tests and reports must be completed by a Nationally Recognized Testing Laboratory
 - 3) All tests must be conducted to IES standards
- h. ColorSource PAR Pearl
 - i. All LED emitters must have a L70 rating of no less than 60,000 hours
 - ii. Substitutes must provide evidence of minimum L70 rating of no less than 60,000 hours via a LM-80 report on all emitters
 - 1) LM-80 report must be provided with a LM-79 report and an in situ temperature measurement test verifying the conditions of the fixture meet the conditions of the LM-80 report
 - 2) All tests and reports must be completed by a Nationally Recognized Testing Laboratory
 - 3) All tests must be conducted to IES standards

3. Physical

- a. The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits.
- b. The housing shall have a rugged black powder-coat finish
 - i. White or silver/gray powder-coat finishes shall be available as colour options
 - ii. Other powder-coat colour options shall be available on request
- c. Power supply, cooling and electronics shall be integral to each unit.

- d. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories
 - e. Slots shall be equipped with locking retaining clip
- 4. The unit shall ship with:
 - a. Theatrical-style hanging yoke as standard
 - b. 1.8m PowerCON to flying leads power cable
 - c. Available options shall include but not be limited to:
 - d. Floor stand conversion Kit
 - e. PowerCON to PowerCON cables for fixture power linking
 - f. Multiple secondary lens options to include multiple angles in the following patterns:
 - i. Linear
 - ii. Round
 - iii. Oblong
- 5. Light output shall be via a round aperture
 - a. Aperture and accessory slots shall accommodate standard 190mmx190mm accessories such as used in other similar-sized fixtures
 - b. Accessories available as options shall include but not be limited to:
 - i. Gel/diffusion frames
 - ii. Top hats
 - iii. Barn doors
 - iv. Egg crate louvers
 - v. Concentric ring louvers
 - vi. Multiple secondary lensing options
- 6. Environmental and Agency Compliance
 - a. The fixture shall be CE compliant, and shall be so labelled when delivered to the job site.
 - b. The fixture shall be UL LISTED to the UL1573 standard for stage and studio use
 - c. The fixture shall be rated for IP-20 dry location use.
- 7. Thermal
 - a. The fixture shall be cooled with a variable speed fan.

- b. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use for colour mixing versions and 36,000 hours of use for Pearl variety
 - i. Thermal management shall include multiple temperature sensors within the housing to include:
 - 1) The LED array
 - 2) The control board
 - c. The fixture shall operate in an ambient temperature range of 0°C minimum to 40° C maximum ambient temperature
8. Electrical
- a. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply
 - b. The fixture shall support power in and thru operation
 - i. Power in shall be via Neutrik® PowerCON input connector
 - ii. Power thru shall be via Neutrik ® PowerCON output connector
 - iii. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker
 - c. The fixture requires power from non-dim source
 - d. Power supply outputs shall have self-resetting current limiting protection
 - e. Power supply shall have power factor correction
9. LED Emitters
- a. The fixture shall contain 4 different LED colours to provide colour characteristics or two colour temperature white LEDs for the Pearl products, as described in Section H below.
 - b. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
 - i. Fixture shall utilise Luxeon® Z™ LED emitters
 - c. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain colour consistency.

- d. LED emitters should be rated for nominal 20,000-hour L70 rating for colour mixing versions and 36,000-hour L70 rating for Pearl variant
- e. LED system shall comply with all relevant patents

10. Calibration

- a. Fixture shall be calibrated at factory for achieve consistent colour between fixtures built at different times and/or from different LED lots or bins
 - i. Calibration data shall be stored in the fixture as a permanent part of on-board operating system
 - ii. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency
 - iii. Fixtures not offering LED calibration shall not be acceptable

11. Color

- a. The fixture shall utilise an minimum of 40 LED emitters
 - i. These emitters shall be made up of Red, Green, Blue and Lime for ColorSource
 - ii. These emitters shall be made up of Red, Green, Indigo and Lime for ColorSource Deep Blue
 - iii. These emitters shall be made up of 2700 K and 6500 K for ColorSource Pearl

12. Dimming

- a. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming.
- b. The dimming curve shall be optimised for smooth dimming over longer timed fades.
- c. The LED system shall be digitally driven using high-speed pulse width modulation (PWM)
- d. LED control shall be compatible with broadcast equipment in the following ways:
 - i. PWM control of LED levels shall be imperceptible to video cameras and related equipment
 - ii. PWM rates shall be adjustable by the user via RDM to avoid any visible interference to video cameras and related equipment

13. Control and User Interface

- a. The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors
- b. The fixture shall be compatible with the ANSI RDM E1.20 standard
 - i. All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
 - ii. Temperature sensors within the luminaire shall be viewable in real time via RDM
 - iii. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible
- a. The fixture shall be equipped with a 7-segment display for easy-to-read status and control
- b. The fixture shall be equipped with a three-button user-interface
- c. The fixture shall offer RGB control
- d. The fixture shall operate in Regulated mode for droop compensation
- e. The fixture shall offer stand-alone functionality eliminating the need for a console
- f. Fixture shall ship with 12 preset colours accessible as a stand-alone feature
- g. Fixture shall ship with 5 Sequences accessible as a stand-alone feature
- h. Each colour and sequence can be modified by the end user
- i. Fixtures can be linked together with standard DMX cables and controlled from designated master fixture
- j. Up to 32 fixtures may be linked
- k. Fixtures in a stand-alone state shall restore to the settings present prior to power cycling, eliminating the need for reprogramming
- l. Fixtures without stand-alone operation features described in a, b, c, d, and e shall not be acceptable.

B. LED SPOT FIXTURES

1. ColorSource Spot V and ColorSource Spot VXT as manufactured by ETC Inc.
Brings together a five-color light engine with the build-quality and support of an ETC product. Uses a mix of red, green, blue, indigo and lime LED emitters.
ETC optics, adapters, and accessories.
 - a. Standards Compliance:
 1. Listed: cETLus, UL 1598, UL 924, CSA C22.2 No. 250.0.
 2. Compliance: CE.
2. Model ColorSource Spot V with shutter barrel, black.
3. Source:
 - a. LED Details: 60 Lumileds LUXEON Rebel and LUXEON C LEDs.
 - b. Max Lumens: 9300.
 - c. Lumens per Watt: 47.2.
 - d. L70 Rating: Greater than 54000 hours.
4. Colors:
 - a. Colors Used Spot: Red, green, blue, indigo, lime.
 - b. Color temperature Range: Color mixing.
 - c. Calibrated Array: Yes.
 - d. Red Shift: No.
5. Optical:
 - a. Beam Angle Range: 5 to 90 degrees. Swappable lens tubes.
 - b. Gate Size: 80 mm.
 - c. Aperture Size: 6.25 to 14 inches depending on lense tube.
 - d. Pattern Projection: Yes.
 - e. Pattern Size: A or B.
 - f. Camera Flicker Control/Hz Range: 5 kHz and 25 kHz.
6. Control:
 - a. Input Method:
 - b. DMX-512 via 5-pin XLR connector. Protocols: DMX512, RDM.
 - c. City Theatrical Multiverse. Protocols: DMX512, RDM
7. NFC Configuration: Yes, via Set Light app.
8. RDM Configuration: Yes.

9. User Interface Type:

- a. ColorSource Spot V: 7-segment 3 button interface.
- b. Local Control: Yes. (ColorSource Spot V only)
- c. Onboard Presets: Yes, 12. Onboard Sequences: Yes, 5. Onboard Effects: No.
- d. Fixture-to-Fixture Control: Yes.
- e. 15-bit virtual dimming engine.

10. Electrical:

- a. Voltage: 100 to 240 VAC, 50 to 60 Hz.
- b. Input Method: powerCON True1 TOP in and thru.
- c. Inrush First Half Cycle: 55 A at 120 V. 59 A at 240 V.
- d. Fixtures per Circuit:
 - 1. Eight. (R20 module or similar).

11. Thermal: Operating Temperature: 32 to 104 degrees F.

- a. Fan: Yes. Controllable.
- b. Droop Compensation: Yes.
- c. BTUs/hour: 671.77.

12. Physical: IP Rating: ColorSource Spot V: IP-20. ColorSource Spot VXT: IP-65

- a. Materials: Die-cast aluminum. Colors: Black, white, silver, or custom.
- b. Mounting Options: Yoke.
- c. Included Accessories: Hanging yoke, 39 inch power cable, soft-focus diffuser in an A-size gobo holder.

PART 4 CONTROLS

4.0 TOUCHSCREEN CONTROL STATIONS

A. The Touchscreen Control Stations shall be the Unison Paradigm Touchscreen P-TS7 Series Control Stations as manufactured by ETC, Inc., or equal.

B. General

- 1. Touchscreen stations shall support default and fully graphical control pages.

2. The Touchscreen station shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
3. Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.

C. Mechanical

1. Touchscreen stations shall consist of a seven inch, backlit liquid crystal display (LCD) with a minimum resolution of 800 by 400 pixels and 24-bit colour depth with a capacitive touch interface.
2. Touchscreen bezels shall be constructed of cast aluminium finished in a fine texture powder coat.
 - i. Touchscreen shall be available in five standard colours (color by architect)
 1. Cream (RAL 9001) , Ivory (RAL 1015), Grey (RAL 7001), Black (RAL 9004), Signal White (RAL 9003)
 2. The bezel shall have no visible means of attachment.
 3. The bezel shall allow the touchscreen to be installed and removed without the use of tools.
 4. The bezel shall provide two working positions for the Touchscreen: service and normal operation.
3. Touchscreen shall offer optional hinged locking covers
 - ii. Locking covers shall be made from cast aluminium and be painted to match standard touchscreen color options
 - iii. Locking covers shall allow for viewing of system status on the touchscreen though a smoked Lexan window
 1. The manufacturer shall provide back boxes for all LCD stations.
 - iv. Flush back box for Touchscreens with or without locking covers shall be 202mm wide x 135.4mm high x 83mm deep
 - v. Surface back box dimensions shall be 211mm wide x 142mm high x 70mm deep
 - vi. Surface back box for Touchscreens with locking cover dimensions shall be 254mm wide x 170mm high x 70mm deep

D. Electrical

1. Touchscreens shall be powered entirely by the System network.
2. Touchscreens shall connect to the System using an Ethernet network with Power over Ethernet (PoE) or the Unison control station Echelon® Link power network.
 - i. Ethernet Network

1. Ethernet network shall be 10/100BaseTX, auto MDI/MDIX, 802.3af (PoE) compliant.
 2. Network shall utilize Unshielded Twisted Pair (UTP) Category 5, or better wiring.
 3. PoE power consumption shall be PoE class 2, consuming no more than 6 watts.
3. Echelon® Link power network.
- i. Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one 2.5mm² ESD drain wire (when not installed in grounded metal conduit).
 - ii. Touchscreen stations shall also require (2) 1.5mm² stranded wires for 24VDC operating power. 24VDC wiring shall be topology free.
 - iii. Network wiring may be bus, loop, home run, star or any combination of these.
 - iv. Network insulation displacement connectors shall be provided with all stations.

E. Functional

1. System

- i. The Touchscreen shall support configuration firmware upload from a Paradigm Processor as proxy
- ii. The Touchscreen shall support configuration or firmware upload from local removable media

2. Setup Mode

- i. There shall be a setup display that is separate from any user-defined configuration
- ii. It shall be possible to view and modify connectivity settings
- iii. It shall be possible to view status information
- iv. It shall be possible to view and modify LCD screen settings
- v. It shall be possible to perform Touchscreen calibration
- vi. It shall be possible to view and modify audio settings
- vii. The appearance of the setup display shall be standard and not editable
- viii. The setup display may be invoked from within the user-defined configuration and/or physical button on the Touchscreen
- ix. There shall be a default protected method to invoke the setup display

3. Configurations

- i. It shall be possible to have multiple configurations stored within an LCD Station

- ii. Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration

4. Operation

- i. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.
 - 1. System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.
 - a. Presets shall have a discrete fade time, programmable from zero to 84,600 seconds with a resolution of one hundred milliseconds.
 - b. Presets shall be selectable via Touchscreen stations.
 - 2. System macros and sequences shall be programmable via LightDesigner system software.
 - a. Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
 - b. Macro and sequences shall be activated by button, time clock event or LightDesigner software.
 - 3. System time clock events shall be programmable via the Touchscreen, LightDesigner system software, the processor user interface, or the internal web server.
 - a. Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
 - b. Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
 - 4. A Colour picker, supporting Hue, Saturation and Brightness (HSB) colour selection shall be available for colour selection of colour changing fixtures and provide visual feedback of the current colour produced by the associated fixture.
 - a. The colour picker shall be provided with a default layout that requires no user configuration
 - b. The Colour Picker shall provide RGB faders in addition to the default HSB colour wheel for colour selection

- c. Colour picker values shall allow for numerical value input in addition to colour wheel and fader control
 - d. The colour picker shall be compatible with colour mixing systems that use up to seven discrete colour control channels
- 5. Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via Unison Paradigm LightDesigner, the Windows-based configuration program.
 - a. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.
 - b. Optional fader functions include master control, individual channel control, fade rate control or preset master control.
 - c. Touchscreen stations shall allow programming of station and component electronic lockout levels via LightDesigner.
 - d. It shall be possible to adjust LCD contrast and brightness.
 - e. It shall be possible to program the station to dim during periods of inactivity.

PART 5 POWER DISTRIBUTION

5.1 CONNECTOR STRIPS

- A. The connector strips shall be the ColorSource Raceway by ETC, Inc., or approved equal

- B. General

- 1. Connector strips shall provide distributed power from incoming circuits to plugs along a raceway
 - 2. Internal wiring shall be sized to circuit ampacity and shall be rated at 125°C
 - 3. Connector strips shall support a combination of line voltage power and low voltage data distribution within a single raceway.
 - 4. Connector strips shall be listed by a nationally recognized test lab (NRTL). Connector strips that are not listed shall not be acceptable

C. Physical

1. Connector strips shall be 127mm H x 45mm D and fabricated from 1.6mm aluminum finished in black, white, or silver fine-texture powder coat paint
2. Connector strips shall be available in any length up to 72ft / 2195cm in specified increments of 1ft / 30.5cm and shipped fully wired with all splicing hardware
3. Connector strips shall weigh no more than 2.5lbs/ft. Connector Strips that weigh more than 2.5lbs/ft shall not be acceptable
4. Two connector panels supporting power and data outlets shall be supported for each 1ft / 30.5cm section of strip and shall be mounted on individual 125mm panels
5. Frames and connector panels shall be fabricated from 3mm die cast aluminum finished in black, white, or silver fine-textured powder coat paint
6. Circuits shall be labeled above each connector on the front of the strip using 15mm reverse silk screened lexan labels. All labels match connector strip finish with contrasting color circuit designations. Optional write-on labels shall be available upon request, connector strips that do not support write-on labels shall not be acceptable
7. Connector strips shall support the use of QR code labels which allow users to access limited circuit configuration controls via Wi-Fi connection from a mobile device application. The mobile application shall be the ThruPower System Reporter (TPSR) app by ETC.
 - a. Mobile application shall select the circuit to configure either by scanning the QR code label applied to circuit distribution or by manual entry of circuit information
 - b. Mobile application shall allow users to set the Control Mode of the selected circuit in order to shift a ThruPower module between Dimmable and Switched mode according to the requirement of a connected load
 - c. Mobile application shall allow users to activate the circuit test function for the selected module
 - d. Circuit distribution systems which do not support mobile circuit configuration from the plugin location of a supported load shall not be acceptable
 - e. Connector strips shall be supplied with appropriate brackets and hardware for mounting.
 - f. Connector strips shall utilize junction brackets on 6ft / 152cm centers and support spans up to 12ft / 305cm between hanger brackets
 - g. Mounting brackets shall be 45mm x 3mm and 45mm x 1.9mm ASTM A5008 steel. All mounting hardware shall conform to ISO 898-1 class 8.8

D. Electrical

1. Connector strip shall support 120V/60Hz power input per branch circuit with support for multiple outlets wired to each circuit
2. The connector strip wiring terminal box shall support a maximum of eight 20A inputs utilized for:
 - a. Up to six circuits for power distribution along the length of the connector strip
 - b. One circuit dedicated for work lights.
 - c. One circuit for DMX Active Pass-thru connectors when required
3. The connector strip terminal box shall support hardwired or pluggable connector power and data input
4. Pluggable power and data inputs shall be fed by a single multi-conductor cable and a single DMX or Ethernet cable. The LKS data connector by Link S.r.l. or Link USA, Inc shall be supported, connector strips that do not support the LKS data connector shall not be accepted
5. Power output connectors shall be available as 20A grounded stage pin, 20A Twist-Lock, 20A “U” ground (dual rated “T-slot”), and 20A Neutrik powerCON TRUE1. Connector strips that utilize connectors that are not rated for plugging hot loads shall not be accepted.
6. Terminations shall be consolidated at one end and utilize feed-through terminals individually labeled with corresponding circuit numbers
 - a. Performance lighting circuits shall utilize tension clamp terminals listed for AWG 20 – 8 / 0.5mm² – 6mm² gauge wire
 - b. Work light and DMX Active Pass-thru circuits shall use tension clamp terminals listed for AWG 20 – 12 / 0.5mm² – 4mm² gauge wire
 - c. Terminals that place a screw directly on the wire are not acceptable
7. A low voltage data distribution system shall be supported to incorporate DMX/ RDM (ANSI E1.11-2008 USITT DMX512-A and ANSI E1.20 Remote Device Management) or Ethernet (IEEE 802.3).
 - a. Ethernet connections shall utilize standard RJ-45 connection
 - b. DMX output ports shall utilize 5-pin XLR style connectors
 - c. Connector strips shall utilize a voltage barrier to accommodate class 2 wiring in the same strip as class one circuits.
 - d. Low voltage signals shall enter the connector strip via a strain relief or connector mounted at the specified end of the connector strip. One low voltage cable shall be supported for each connector strip
 - e. Connector strips with multiple DMX outputs shall use active DMX/RDM pass through assemblies. Each strip shall support up to 24 active DMX/RDM pass through assemblies
 - f. DMX outputs without active splitting of the DMX/ RDM signal or that do not support RDM shall not be acceptable

E. Pipe Batten

1. A pipe batten with a 48.3mm outside diameter constructed of 3.8mm extruded aluminum with a 3.8mm vertical web shall be available for use with the connector strip
2. The pipe batten shall be extruded with a witness line to indicate the position of the web
3. The pipe batten shall support a maximum distributed load of 150lb / 68kg over a 10ft / 305cm span
4. The pipe batten shall support a maximum point load of 65lb / 29kg over a 10ft / 305cm span
5. The pipe batten shall weigh no more than 1.5lbs/ft, battens that weighs more than 1.5lbs/ft shall not be acceptable
6. The pipe batten shall be designed to a 10:1 safety factor
7. The pipe batten shall be finished with black or clear hardcoat anodization
8. Provide hanging brackets compatible with the size of the electrics and battens to be provided. Quantity shall be per manufacturers recommendations per linear foot of batten to be provided. Unless otherwise noted, assume pipe batten & electrics to be dead hung.

F. Megabatten Connector Strip

1. The patented MegaBatten constructed from 1-1/2" extra strong schedule 80 aluminum pipe, with power and data distribution built in.
 - i. Up to 100' in length, built from 8', 4', 32", 16" lengths with internal splices.
 - ii. From 1-6 20A circuits, available to be fed from both ends.
 - iii. Power and data outlet plates on 16" centers
 - iv. Powder coated, available in matte black, eggshell white, or custom RAL colors.
 - v. Pre-wired at the factory for ease of installation
 - vi. Product shall be ETL rated.
2. Data Distribution
 - i. Product shall be available with or without DMX-512A/RDM data distribution.
 - ii. DMX is connected to the MegaBatten in the DMX/RDM splitter box mounted to the side opposite the Output Plates.
 - iii. DMX splitter comes with a 1-In, 3-Out splitter comprising 1 universe. By extending the box the batten can accommodate an additional 2 Universes.
 - iv. The last plate of the DMX output is terminated.
 - v. DMX Output connectors available: 5pin XLR, 3pin XLR, RJ45
3. Power & Connector Options
 - i. Terminal box
 - ii. 19 Pin Connector(s)
 - iii. Wire Leads extended from inside up to 100'.

- iv. 12/3,4, or 5 type SO Cable for 1 to 3 circuits.
- v. 20A Flush Mount 5-20 “Edison” connectors shall be available.

G. Work Lights

- 1. Connector strips shall support optional integrated LED work lights
- 2. The work lights shall mount to the bottom of the supplied hanger bracket
- 3. A connector plate shall be available to install a power supply for the work light
- 4. The work light shall be a 25W 3000K CCT LED array at 90 CRI
- 5. The work light shall produce 1600 lumens
- 6. The work light shall have a 60° beam angle
- 7. Connector strips that do not support integrated LED work lights shall not be acceptable

H. Junction Boxes

- 1. Gridiron junction boxes shall be available to accommodate “S” type cable wiring into connector strips mounted to non-fixed locations
- 2. Junction boxes shall accommodate hardwired or pluggable cables including LKS data connector by Linek S.r.l. or Link USA, Inc. Junction boxes that do not support the LKS data connector shall not be acceptable
- 3. Junction boxes shall be fabricated from 16-gauge cold rolled steel with 14-gauge end panels
- 4. Cover(s) shall be 16-gauge cold rolled steel and hinged to allow mounting in any direction
- 5. Junction Boxes shall be finished with fine-textured, scratch-resistant, powder coat paint

PART 6 EXECUTION

6.1 CONTRACTORS DOCUMENTATION

- A. As-Built Drawings. Provide three (3) sets. The Contractor shall provide complete point to point wiring schematics of all system components including audio, video and control. Drawings shall include cable numbering, equipment locations, jacks, input /output plates etc.
- B. A final set of as-built drawings shall be provided within 10 working days of acceptance by the Owner. Two copies of this as-built information shall be provided one to the Owner and one to the Engineer. As-builts shall be provided on reproducible media, and one CD Rom

- C. The Contractor is to keep on file a complete set of as-built drawings to be used for future service actions and future system enhancements.
- D. Any and all custom furniture, carts, consoles etc. shall be documented in CAD form and provided with the as-builts.
- E. Manufacturer Documents - Provide three (3) sets. All equipment item manufacturer manuals shall be provided as a part of the Contractors documentation package. All manuals are to be inserted into 3 ring binders. Also included in these binders are to be a complete equipment list of the serial numbers and manufacturer warranty information

6.2 COOPERATION WITH OTHER TRADES

- A. It shall be the responsibility of the Contractor to cooperate at all times, and to the fullest extent, with all trades doing work in the building.
- B. The Contractor shall be responsible to meet anticipated project schedules regardless of any and all local disputes.

6.3 INSTALLATION STANDARDS

- A. Qualified technicians shall perform all equipment, cabling and materials installation in a professional manner, in accordance with industry standards.
- B. All equipment (permanent and portable) will be mechanically mounted as needed to prevent any unwanted movement (instability, vibration) during normal usage.
- C. All mounting hardware and/or brackets shall be concealed wherever possible. The same type of hardware shall be used on all wall plates.
- D. All equipment will be mounted with symmetry and center of gravity in mind
- E. All cabling on portable equipment will be dressed neatly and orderly with care taken that no cabling can be "snagged" when it is being moved.
- F. All control cabling will be installed within the NEC installation parameters for application and routing
- H. Cabling:
 - a. All cabling will be installed in a neat and orderly fashion

- b. Cabling will be secured and strain-relieved at all appropriate locations
- c. All cable connections to equipment will have maximum accessibility and cable labels will be visible.
- d. Any piece of equipment will be removable without cutting wire ties or cable harnesses
- e. Service loops will be provided where necessary.
- f. All cables run through plenum environments will be Teflon-jacketed in accordance with local fire codes.
- g. Cables will not be gouged, bent, or otherwise damaged during installation or termination. Cables will not rest against any sharp metal edges. Grommets, plastic collars, or rubberized tape will be used where appropriate
- h. Cables and bundles will be dressed to look neat, orderly, and with the idea that a technician, who may be unfamiliar with the system, can find his or her way around the system with the aid of the documentation

6.4 MANUFACTURER'S SERVICES

- A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the owner that the system is available for formal checkout.
- B. Notification shall be provided in writing, two weeks prior to the time factory-trained personnel are needed on the job site if applicable.
- C. The contractor shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.
- D. Upon completion of the formal check-out, the contractor shall demonstrate operation and maintenance of the system to the owner's representatives. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system. The first training session shall be a minimum of four hours. Training shall consist of detailed operating functions, and hands on system and overall explanations of each systems capabilities and functionality. A user's manual shall be used as a guide for training. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of two hours.

6.5 OWNER TRAINING

- A. Training shall be provided to the owner for all installed systems. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system.

- a. Each training session shall be a minimum of two hours.
- b. Training shall consist of detailed operating functions and overall explanations of each systems capabilities and functionality.
- c. A user's manual shall be used as a guide for training.
- d. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of one hour
- e. Contractor shall be present for the first event during operation.
- f. All training sessions shall be video-taped. The tape shall be turned over to the Owner for future reference

6.6 WARRANTY

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery.
- B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.
- C. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.
- D. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.

END OF SECTION 26 2000

SECTION 271005 - STRUCTURED CABLING FOR VOICE AND DATA

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications identification.
- F. Telecommunications service entrance to building(s).
- G. Cabling and pathways inside building(s).
- H. Cabling and pathways connecting building(s).
- I. Distribution frames, cross-connection equipment, enclosures, and outlets.
- J. Grounding and bonding the telecommunications distribution system.

1.2 RELATED REQUIREMENTS

- A. Section 337119 - Electrical Underground Ducts and Manholes.
- B. Section 078400 - Firestopping.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260534 - Conduit.
- E. Section 260536 - Cable Trays for Electrical Systems.
- F. Section 260537 - Boxes.
- G. Section 262726 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.
- B. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.
- C. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements; Insulated Cable Engineers Association; 2012. (ANSI/ICEA S-90-661)
- D. NECA/BICSI 568 - Standard for Installing Building Telecommunications Cabling; National Electrical Contractors Association; 2006. (ANSI/NECA/BICSI 568)
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; Telecommunications Industry Association; 2012.
- G. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; Telecommunications Industry Association; Rev A, 2009.
- H. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; Telecommunications Industry Association; 1998 (R 2002).
- I. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; Telecommunications Industry Association; Rev A, 2015.
- J. TIA-526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Telecommunications Industry Association; Rev C, 2015.
- K. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; Telecommunications Industry Association; 2015.
- L. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Telecommunications Industry Association; Rev C, 2009 (with Addenda; 2014).
- M. TIA-568-C.3 - Optical Fiber Cabling Components Standard; Telecommunications Industry Association; 2008 (with Addenda; 2011).
- N. TIA-569-C - Telecommunications Pathways and Spaces; Telecommunications Industry Association; Rev C, 2012 (with Addenda; 2013).

- O. TIA-570-C - Residential Telecommunications Infrastructure Standard; Telecommunications Industry Association; Rev C, 2012.
- P. TIA-606-B - Administration Standard for the Telecommunications Infrastructure; Telecommunications Industry Association; Rev B, 2012.
- Q. TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Telecommunications Industry Association; Rev B, 2012 (with Addenda; 2013).
- R. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.
- S. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- T. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; Current Edition, Including All Revisions.
- U. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.
- V. USDA RUS 345-83 - Gas Tube Surge Arrestors (PE-80); US Department of Agriculture; 1982.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
 - 3. Testing reports/certifications of installation/cable lengths.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Certified Registered Communications Distribution Designer (RCDD).
- D. Manufacturer Qualifications.
- E. Evidence of qualifications for installer.
- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.

2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
3. Identify distribution frames and equipment rooms by room number on contract drawings.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 10 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 10 years experience in the installation and testing of the type of system specified, and:
 1. Bidder shall be a member of BICSI (Building Industry Consulting Service International).
 2. Supervisors and installers factory certified by manufacturers of products to be installed – minimum of (2) individuals certified.
 3. The Successful Bidder shall have on staff at least one employee who holds a BICSI RCDD (Registered Communications Distribution Designer) certification. Provide proof of certification with submittals.
 4. “A minimum of 75% of all staff providing work as part of this specification shall hold a BICSI Installer 2 certification (INSTC for copper and INSTF for fiber) specific to their area of labor (copper and/or fiber) OR the BICSI Technician (TECH). Provide proof of current certification with submittals.
 5. The Successful Bidder shall have on staff at least one employee who holds a BICSI RTPM (Registered Telecommunications Project Manager) certification. Provide proof of certification with submittals.
 6. The Successful Bidder must be a certified Hubbell installer and provide proof of being part of the Hubbell Mission Critical Warranty Program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 60 period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cabling and Equipment:
- B. Mohawk Copper Cabling
 - 1. Substitutions:
 - a. Hubbell Premise Wiring.
 - b. See Section 260100 - Product Requirements.

2.2 SYSTEM DESIGN

- A. Provide a complete permanent Fiber and Cat 6A system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures, cabinets, racks, and outlets.
 - 1. Comply with TIA-568 (cabling) and TIA-569 (pathways), latest editions (commercial standards). Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
 - 2. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 3. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
 - 4. The District will furnish the switches, servers, and wireless access points (WAP'S). Provide end-to-end wiring starting at the incoming service from the pole to the Electric Room, from Electric Room to the MDF Room switch to the patch panels, from the MDF patch panels to the IDF, from the IDF patch panels to the data ports or WAP's. UPS will be furnished and installed by the district. Contractor shall provide Nema 5-20R receptacle outlet at each rack. Quantity per drawings.
 - 5. Provide vertical mount PDUs at each rack.
 - a. Hubbell cat#PR10420
- B. Capacity:
 - 1. Building Entrance: Existing
 - 2. Horizontal Cabling
 - a. MDF to IDF's
 - 1) Armored 6 strand single mode (OS2) fiber optic. Hubbell PN# HFC15006PS and 12 strand multi mode armored (OM5) fiber optic. Hubbell PN # HFC15012P5
 - 2) CAT 6A cabling to outlet ports:
 - (a) Refer to the drawings for exact counts of ports per outlet device.
 - (b) Refer to floor plans for camera locations (1 drop per location). Coordinate final camera locations with district prior to rough-in.
 - (c) Refer to floor plans for WAP locations (4 drops per location) Coordinate final WAP locations with district prior to rough-in.

- C. Main Distribution Frame (MDF): Centrally located support structure for terminating backbone cables, functioning as point of presence to external service provider.
 - 1. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
- D. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
- E. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
- F. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.3 PATHWAYS

- A. Conduit: As specified in Section 260534; provide pull cords in all conduit.
- B. Cable Trays: As specified in Section 260536.
- C. Underground Service Entrance: PVC, Type EPC-40 conduit.

2.4 COPPER CABLE AND TERMINATIONS

- A. Copper Horizontal Cable: TIA/EIA-568 Category 6A solid conductor unshielded twisted pair (UTP), 23 AWG, 100 ohm; 4 individually twisted pairs; covered with jacket colors as indicated below and complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444.
 - 1. In plenums, provide NFPA 70 type CMP plenum-rated cable. Mohawk PN#M59146.
 - 2. Testing: Furnish factory reel tests.
 - 3. Color coding of cable shall be as follows for the listed applications. Note Red shall be reserved for Fire Alarm Cabling only.
 - a. Data Drops (standard drops) - Blue
- C. Copper Cable Terminations:
 - 1. Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 - 1. Performance: 500 mating cycles.
 - 2. Keystone jacks shall be Hubbell HXJ6X.
 - 3. Terminations shall be completed in ANSI TIA-568B pinout fashion

2.5 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Fiber Optic Interconnecting Devices:
 - 1. Connector Type: Type LC.
 - 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 - 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
- B. Fiber Optic Backbone Cable - Multimode Fiber Cable:. Provide 1 – 12 Strand multimode fiber and 1-6 strand single mode fiber from each IDF to the MDF.
 - 1. Pre-terminated, tight buffered, interlocking armored cable, riser, 50 microns, OM5, multimode mode indoor/outdoor and plenum rated. Comply with TIA-492AAAD and and TIA/EIA – 568.
 - 2. Jacket Color: Aqua
 - 3. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - 4. Jacket shall be imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches
 - 5. Cable should be UL listed for installation and purpose
- D. Fiber Patch Cords shall consist of quantities as required but shall consist of a minimum as follows:
 - 1. 10 each Hubbell # DFPCLCSCE1MM, 1 meter, aqua jacket, Multimode
- F. Fiber Optic Adapters and Connectors: Duplex LC, push-on-push-off type, multimode adaptors with zirconia ceramic alignment sleeves; complying with relevant parts and addenda to latest edition of TIA/EIA-568 and with maximum attenuation of 0.3 dB at 1300 nm with less than 0.2 dB change after 500 mating cycles when tested in accordance with TIA-455-21.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. All labeling shall be machine print. No handwritten labeling shall be accepted. Each cable shall be labeled on both the patch panel and on the wall faceplate/biscuit box as applicable

2.7 CROSS-CONNECTION EQUIPMENT

- A. Connector Blocks for Category 6A and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.

- B. Patch Panels for Copper Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface. Provide Hubbell #HP6A48, Comes with Rear management bar
1. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 2. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 3. Labels: Factory installed laminated plastic nameplates above each port, numbered per district standards; comply with TIA/EIA-606 using encoded identifiers. No exceptions unless pre-approved by District.
 - a. District standard label for wall plates and WAPs: Room # - Port #
 - b. District standard label for camera ports: Room/Corridor # - Port #
 - c. District standard label for all other ports: Room/Corridor # - Port #
 4. Provide incoming cable strain relief and routing guides on back of panel.
 5. Patch Cords: Provide one patch cord for each pair of patch panel ports.
 - a. Patch Cords shall be as manufactured by FS; <https://www.fs.com/>
 1. 30% - 5ft Yellow FS Part #148293
 2. 20% - 5ft Blue FS Part #70748
 3. 20% - 1ft Yellow FS Part #148281
 4. 20% - 1ft Green FS Part #148282
 5. 10% - 2ft Green FS Part #148285
 6. For every 1 piece of building automation equipment that requires a network connection, provide (1) FS Part#185700 (white) and (20) FS Part #185701 as spare.
 6. Manufacturer's patch cords must be used to provide a Channel Warranty
 7. Category 6A panels shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568.2-D, Transmission Performance specifications for 4-pair 100 OHM cat 6A cabling systems
 8. Panels shall be tested to 150% of IEEE 802.3bt DTE Power specification with no degradation of performance or materials
 9. Stainless steel face plates must be used. Hubbell SSFL series
- C. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
1. Adaptors: As specified above under FIBER OPTIC CABLING; maximum of 24 duplex adaptors per standard panel width.
 2. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
 3. Provide incoming cable strain relief and routing guides on back of panel.
 4. Provide rear cable management tray at least 8 inches deep with removable cover.
 5. Provide dust covers for unused adaptors.
 6. Patch Cords: Provide one patch cord for each pair of patch panel ports.

2.8 ENCLOSURES

- A. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
 - 1. Size: 48 inches wide by 96 inches high.
 - 2. Do not paint over UL label.
- B. Equipment Racks and Cabinets: CEA-310 standard 19 inch wide component racks.
 - 1. Floor Mounted Racks: 16 gauge steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug. Provide Hubbell #HPW84RR19D, with Vertical Cable Managers VME614C2
 - 2. Provide 2-post racks (Hubbell HPW90RR19).
- C. Building Entrance Protector: Factory fabricated panel to connect incoming cable and interior cable to protector modules.
 - 1. Capacity: One protector module per pair in incoming cable.
 - 2. Protector Modules: Type rated for the application.
 - a). Solid State Type: Complying with UL 497.
 - 3. Incoming Side: Provide connector blocks of type specified.
 - 4. Outgoing Side (to Interior): Backbone cable wired to connector blocks.
- D. Outlet Boxes: For flush mounting in walls; depth as required to accommodate cable manufacturers recommended minimum conductor bend radius.
 - 1. Size, unless otherwise indicated: 4 inches square by 3.5 inches deep.
 - 2. Faceplates: Stainless steel. Final material/color selection by Architect. Faceplates shall coordinate with connectors provided. Include label and label cover with faceplate. Machine print.
 - 3. Labels: Comply with TIA/EIA-606 using encoded identifiers; label each jack on the face plate per District provided labeling schematic.

2.9 POWER DISTRIBUTION UNIT (PDU)

- A. Equipment Racks and Enclosures:
 - 1. Hubbell cat#PR10420

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

- B. Comply with latest editions and addenda of TIA-570, TIA-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- C. Comply with Communication Service Provider requirements.
- D. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

3.2 INSTALLATION OF PATHWAYS

- A. Install with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit:
 - 1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
 - 2. Leave pull cords in place where cables are not initially installed.
 - 3. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
 - a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
 - b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
 - c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
 - d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.
 - 4. Provide pull string in all under slab conduit.
- C. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.
- D. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 078400.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.

4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
 5. Cable runs shall not exceed 295 feet.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches.
 2. At Outlets including wall - Copper: 12 inches.
 3. At Outlets - Optical Fiber: 39 inches.
 4. At WAP locations: 120 inches
 5. At security camera locations: 120 inches
 6. At outlets servicing mechanical equipment and controls: 120 inches
- C. Copper Cabling:
1. Category 6A: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 3. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.
- D. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Floor-Mounted Racks and Enclosures: Permanently anchor to floor and ceiling in accordance with manufacturer's recommendations.
- F. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
1. Cables: Install color coded labels on both ends.
 2. Outlets: Label each jack on its face plate according to District standards with a unique numerical identifier.
 3. Patch Panels: Label each jack according to District standards with a unique numerical identifier.
- G. Each data rack shall consist of the following (in order from top to bottom). Field coordinate exact order with District.
1. Fiber connection at top of rack
 2. 48-port patch panel
 3. Horizontal panduit
 4. Network switch
 5. 48-port patch panel
 6. Horizontal Panduit
 7. Network Switch
 8. Back-up UPS (furnished and installed by District)

3.4 FIELD QUALITY CONTROL

- A. Comply with inspection and testing requirements of specified installation standards.
- B. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- C. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 - 3. Test operation of shorting bars in connection blocks.
 - 4. Category 6A Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- D. Testing - Fiber Optic Cabling:
 - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 - 2. Multimode Backbone: Perform tests in accordance with TIA/EIA-526-14 Method B.

END OF SECTION 271005

SECTION 271005 - STRUCTURED CABLING FOR VOICE AND DATA

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications identification.
- F. Telecommunications service entrance to building(s).
- G. Cabling and pathways inside building(s).
- H. Cabling and pathways connecting building(s).
- I. Distribution frames, cross-connection equipment, enclosures, and outlets.
- J. Grounding and bonding the telecommunications distribution system.

1.2 RELATED REQUIREMENTS

- A. Section 337119 - Electrical Underground Ducts and Manholes.
- B. Section 078400 - Firestopping.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260534 - Conduit.
- E. Section 260536 - Cable Trays for Electrical Systems.
- F. Section 260537 - Boxes.
- G. Section 262726 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.
- B. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.
- C. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements; Insulated Cable Engineers Association; 2012. (ANSI/ICEA S-90-661)
- D. NECA/BICSI 568 - Standard for Installing Building Telecommunications Cabling; National Electrical Contractors Association; 2006. (ANSI/NECA/BICSI 568)
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; Telecommunications Industry Association; 2012.
- G. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; Telecommunications Industry Association; Rev A, 2009.
- H. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; Telecommunications Industry Association; 1998 (R 2002).
- I. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; Telecommunications Industry Association; Rev A, 2015.
- J. TIA-526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Telecommunications Industry Association; Rev C, 2015.
- K. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; Telecommunications Industry Association; 2015.
- L. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Telecommunications Industry Association; Rev C, 2009 (with Addenda; 2014).
- M. TIA-568-C.3 - Optical Fiber Cabling Components Standard; Telecommunications Industry Association; 2008 (with Addenda; 2011).
- N. TIA-569-C - Telecommunications Pathways and Spaces; Telecommunications Industry Association; Rev C, 2012 (with Addenda; 2013).

- O. TIA-570-C - Residential Telecommunications Infrastructure Standard; Telecommunications Industry Association; Rev C, 2012.
- P. TIA-606-B - Administration Standard for the Telecommunications Infrastructure; Telecommunications Industry Association; Rev B, 2012.
- Q. TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Telecommunications Industry Association; Rev B, 2012 (with Addenda; 2013).
- R. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.
- S. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- T. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; Current Edition, Including All Revisions.
- U. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.
- V. USDA RUS 345-83 - Gas Tube Surge Arrestors (PE-80); US Department of Agriculture; 1982.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
 - 3. Testing reports/certifications of installation/cable lengths.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Certified Registered Communications Distribution Designer (RCDD).
- D. Manufacturer Qualifications.
- E. Evidence of qualifications for installer.
- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.

2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
3. Identify distribution frames and equipment rooms by room number on contract drawings.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 10 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 10 years experience in the installation and testing of the type of system specified, and:
 1. Bidder shall be a member of BICSI (Building Industry Consulting Service International).
 2. Supervisors and installers factory certified by manufacturers of products to be installed – minimum of (2) individuals certified.
 3. The Successful Bidder shall have on staff at least one employee who holds a BICSI RCDD (Registered Communications Distribution Designer) certification. Provide proof of certification with submittals.
 4. “A minimum of 75% of all staff providing work as part of this specification shall hold a BICSI Installer 2 certification (INSTC for copper and INSTF for fiber) specific to their area of labor (copper and/or fiber) OR the BICSI Technician (TECH). Provide proof of current certification with submittals.
 5. The Successful Bidder shall have on staff at least one employee who holds a BICSI RTPM (Registered Telecommunications Project Manager) certification. Provide proof of certification with submittals.
 6. The Successful Bidder must be a certified Hubbell installer and provide proof of being part of the Hubbell Mission Critical Warranty Program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 60 period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cabling and Equipment:
- B. Mohawk Copper Cabling
 - 1. Substitutions:
 - a. Hubbell Premise Wiring.
 - b. See Section 260100 - Product Requirements.

2.2 SYSTEM DESIGN

- A. Provide a complete permanent Fiber and Cat 6A system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures, cabinets, racks, and outlets.
 - 1. Comply with TIA-568 (cabling) and TIA-569 (pathways), latest editions (commercial standards). Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
 - 2. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 3. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
 - 4. The District will furnish the switches, servers, and wireless access points (WAP'S). Provide end-to-end wiring starting at the incoming service from the pole to the Electric Room, from Electric Room to the MDF Room switch to the patch panels, from the MDF patch panels to the IDF, from the IDF patch panels to the data ports or WAP's. UPS will be furnished and installed by the district. Contractor shall provide Nema 5-20R receptacle outlet at each rack. Quantity per drawings.
 - 5. Provide vertical mount PDUs at each rack.
 - a. Hubbell cat#PR10420
- B. Capacity:
 - 1. Building Entrance: Existing
 - 2. Horizontal Cabling
 - a. MDF to IDF's
 - 1) Armored 6 strand single mode (OS2) fiber optic. Hubbell PN# HFC15006PS and 12 strand multi mode armored (OM5) fiber optic. Hubbell PN # HFC15012P5
 - 2) CAT 6A cabling to outlet ports:
 - (a) Refer to the drawings for exact counts of ports per outlet device.
 - (b) Refer to floor plans for camera locations (1 drop per location). Coordinate final camera locations with district prior to rough-in.
 - (c) Refer to floor plans for WAP locations (4 drops per location) Coordinate final WAP locations with district prior to rough-in.

- C. Main Distribution Frame (MDF): Centrally located support structure for terminating backbone cables, functioning as point of presence to external service provider.
 - 1. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
- D. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
- E. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
- F. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.3 PATHWAYS

- A. Conduit: As specified in Section 260534; provide pull cords in all conduit.
- B. Cable Trays: As specified in Section 260536.
- C. Underground Service Entrance: PVC, Type EPC-40 conduit.

2.4 COPPER CABLE AND TERMINATIONS

- A. Copper Horizontal Cable: TIA/EIA-568 Category 6A solid conductor unshielded twisted pair (UTP), 23 AWG, 100 ohm; 4 individually twisted pairs; covered with jacket colors as indicated below and complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444.
 - 1. In plenums, provide NFPA 70 type CMP plenum-rated cable. Mohawk PN#M59146.
 - 2. Testing: Furnish factory reel tests.
 - 3. Color coding of cable shall be as follows for the listed applications. Note Red shall be reserved for Fire Alarm Cabling only.
 - a. Data Drops (standard drops) - Blue
- C. Copper Cable Terminations:
 - 1. Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 - 1. Performance: 500 mating cycles.
 - 2. Keystone jacks shall be Hubbell HXJ6X.
 - 3. Terminations shall be completed in ANSI TIA-568B pinout fashion

2.5 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Fiber Optic Interconnecting Devices:
 - 1. Connector Type: Type LC.
 - 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 - 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
- B. Fiber Optic Backbone Cable - Multimode Fiber Cable:. Provide 1 – 12 Strand multimode fiber and 1-6 strand single mode fiber from each IDF to the MDF.
 - 1. Pre-terminated, tight buffered, interlocking armored cable, riser, 50 microns, OM5, multimode mode indoor/outdoor and plenum rated. Comply with TIA-492AAAD and TIA/EIA – 568.
 - 2. Jacket Color: Aqua
 - 3. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - 4. Jacket shall be imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches
 - 5. Cable should be UL listed for installation and purpose
- D. Fiber Patch Cords shall consist of quantities as required but shall consist of a minimum as follows:
 - 1. 10 each Hubbell # DFPCLCSCE1MM, 1 meter, aqua jacket, Multimode
- F. Fiber Optic Adapters and Connectors: Duplex LC, push-on-push-off type, multimode adaptors with zirconia ceramic alignment sleeves; complying with relevant parts and addenda to latest edition of TIA/EIA-568 and with maximum attenuation of 0.3 dB at 1300 nm with less than 0.2 dB change after 500 mating cycles when tested in accordance with TIA-455-21.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. All labeling shall be machine print. No handwritten labeling shall be accepted. Each cable shall be labeled on both the patch panel and on the wall faceplate/biscuit box as applicable

2.7 CROSS-CONNECTION EQUIPMENT

- A. Connector Blocks for Category 6A and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.

- B. Patch Panels for Copper Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface. Provide Hubbell #HP6A48, Comes with Rear management bar
1. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 2. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 3. Labels: Factory installed laminated plastic nameplates above each port, numbered per district standards; comply with TIA/EIA-606 using encoded identifiers. No exceptions unless pre-approved by District.
 - a. District standard label for wall plates and WAPs: Room # - Port #
 - b. District standard label for camera ports: Room/Corridor # - Port #
 - c. District standard label for all other ports: Room/Corridor # - Port #
 4. Provide incoming cable strain relief and routing guides on back of panel.
 5. Patch Cords: Provide one patch cord for each pair of patch panel ports.
 - a. Patch Cords shall be as manufactured by FS; <https://www.fs.com/>
 1. 30% - 5ft Yellow FS Part #148293
 2. 20% - 5ft Blue FS Part #70748
 3. 20% - 1ft Yellow FS Part #148281
 4. 20% - 1ft Green FS Part #148282
 5. 10% - 2ft Green FS Part #148285
 6. For every 1 piece of building automation equipment that requires a network connection, provide (1) FS Part#185700 (white) and (20) FS Part #185701 as spare.
 6. Manufacturer's patch cords must be used to provide a Channel Warranty
 7. Category 6A panels shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568.2-D, Transmission Performance specifications for 4-pair 100 OHM cat 6A cabling systems
 8. Panels shall be tested to 150% of IEEE 802.3bt DTE Power specification with no degradation of performance or materials
 9. Stainless steel face plates must be used. Hubbell SSFL series
- C. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
1. Adaptors: As specified above under FIBER OPTIC CABLING; maximum of 24 duplex adaptors per standard panel width.
 2. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
 3. Provide incoming cable strain relief and routing guides on back of panel.
 4. Provide rear cable management tray at least 8 inches deep with removable cover.
 5. Provide dust covers for unused adaptors.
 6. Patch Cords: Provide one patch cord for each pair of patch panel ports.

2.8 ENCLOSURES

- A. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
 - 1. Size: 48 inches wide by 96 inches high.
 - 2. Do not paint over UL label.
- B. Equipment Racks and Cabinets: CEA-310 standard 19 inch wide component racks.
 - 1. Floor Mounted Racks: 16 gauge steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug. Provide Hubbell #HPW84RR19D, with Vertical Cable Managers VME614C2
 - 2. Provide 2-post racks (Hubbell HPW90RR19).
- C. Building Entrance Protector: Factory fabricated panel to connect incoming cable and interior cable to protector modules.
 - 1. Capacity: One protector module per pair in incoming cable.
 - 2. Protector Modules: Type rated for the application.
 - a). Solid State Type: Complying with UL 497.
 - 3. Incoming Side: Provide connector blocks of type specified.
 - 4. Outgoing Side (to Interior): Backbone cable wired to connector blocks.
- D. Outlet Boxes: For flush mounting in walls; depth as required to accommodate cable manufacturers recommended minimum conductor bend radius.
 - 1. Size, unless otherwise indicated: 4 inches square by 3.5 inches deep.
 - 2. Faceplates: Stainless steel. Final material/color selection by Architect. Faceplates shall coordinate with connectors provided. Include label and label cover with faceplate. Machine print.
 - 3. Labels: Comply with TIA/EIA-606 using encoded identifiers; label each jack on the face plate per District provided labeling schematic.

2.9 POWER DISTRIBUTION UNIT (PDU)

- A. Equipment Racks and Enclosures:
 - 1. Hubbell cat#PR10420

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

- B. Comply with latest editions and addenda of TIA-570, TIA-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- C. Comply with Communication Service Provider requirements.
- D. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

3.2 INSTALLATION OF PATHWAYS

- A. Install with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit:
 - 1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
 - 2. Leave pull cords in place where cables are not initially installed.
 - 3. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
 - a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
 - b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
 - c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
 - d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.
 - 4. Provide pull string in all under slab conduit.
- C. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.
- D. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 078400.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.

4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
 5. Cable runs shall not exceed 295 feet.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches.
 2. At Outlets including wall - Copper: 12 inches.
 3. At Outlets - Optical Fiber: 39 inches.
 4. At WAP locations: 120 inches
 5. At security camera locations: 120 inches
 6. At outlets servicing mechanical equipment and controls: 120 inches
- C. Copper Cabling:
1. Category 6A: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 3. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.
- D. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Floor-Mounted Racks and Enclosures: Permanently anchor to floor and ceiling in accordance with manufacturer's recommendations.
- F. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
1. Cables: Install color coded labels on both ends.
 2. Outlets: Label each jack on its face plate according to District standards with a unique numerical identifier.
 3. Patch Panels: Label each jack according to District standards with a unique numerical identifier.
- G. Each data rack shall consist of the following (in order from top to bottom). Field coordinate exact order with District.
1. Fiber connection at top of rack
 2. 48-port patch panel
 3. Horizontal panduit
 4. Network switch
 5. 48-port patch panel
 6. Horizontal Panduit
 7. Network Switch
 8. Back-up UPS (furnished and installed by District)

3.4 FIELD QUALITY CONTROL

- A. Comply with inspection and testing requirements of specified installation standards.
- B. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- C. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 - 3. Test operation of shorting bars in connection blocks.
 - 4. Category 6A Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- D. Testing - Fiber Optic Cabling:
 - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 - 2. Multimode Backbone: Perform tests in accordance with TIA/EIA-526-14 Method B.

END OF SECTION 271005

SECTION 275134 – INTERCOM AND PA

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

- A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.
- B. All bids shall be based on the equipment as specified herein. The catalog numbers and model designations are that of the Bogen Nyquist E7000MCR Educational Communications System. The specifying authority must approve any alternative system.
- C. Contractors who wish to submit alternative equipment shall provide the specifying authority with the appropriate documentation at least 14 business days prior to bid opening. Alternative systems, if any, shall only be considered as add/deduct alternates. The submitted documentation must provide a feature-by-feature comparison identifying how the proposed equipment meets the operation and functionality of the system described in this specification. Prior to bid date, the contractor shall provide adequate and complete submittal information, which shall include but not be limited to specification sheets, working drawings, shop drawings, and system demonstration. The alternative supplier-contractor must also provide a list to include six installations identical to the proposed system.
- D. The contractor shall provide the FCC registration number of the proposed system, where applicable.
- E. Final approval of the alternative system shall be determined at the time of job completion. Failure to provide the "precise functional equivalent" shall result in the removal of the alternative system at the contractor's expense.
- F. The contractor for this work shall have read all the bidding requirements, the general requirements of division xxxxxx, and the contract proposal forms, and shall be held to the execution of this work. The contractor shall be bound by all the conditions and requirements therein.
- G. The contractor shall be responsible for providing a complete functional system, including all necessary components whether included in this specification or not.
- H. In preparing the bid, the contractor should consider that no claim will be made against the owner for any costs incurred by the contractor for any equipment demonstrations requested by the owner.

1.02 SCOPE OF WORK

The contractor shall furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating VoIP school communications system.

1.03 SUBMITTALS

- A. Spec Sheets on all items including cable types
- B. Outline drawing of system control cabinet showing relative position of all major components
- C. Shop drawings, detailing integrated electronic communications network system including, but not limited to, the following:
 - 1. Station wiring arrangement
 - 2. Equipment cabinet detail drawing
- D. Wiring diagrams showing typical connections for all equipment
- E. Numbered Certificate of Completion for installation, programming, and service training, which identifies the installing technician(s) as having successfully completed the Nyquist E7000 technical training course provided by the Bogen Communications LLC

1.04 QUALITY ASSURANCE

- A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
- B. The contractor shall be an established communications and electronics contractor that maintains a locally run and operated business and has done so for at least 10 years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.
- C. The contractor shall show satisfactory evidence, upon request, that he or she maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain at his or her facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

1.05 SINGLE SOURCE RESPONSIBILITY

- A. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and a minimum of 30 years of experience in the industry. The supplying contractor shall have attended the manufacturer's installation and service training classes. A certificate of this training shall be provided with the contractor's submittal.

1.06 SAFETY / COMPLIANCE TESTING

The communications system and its components shall, where applicable, bear the label of a Nationally Recognized Testing Laboratory (NRTL), such as Environmental Technology Laboratory (ETL), and shall be listed by their re-examination service. All work must be completed in strict accordance with all applicable electrical codes, under direction of a qualified and factory-approved contractor, and to the approval of the owner.

1.07 IN-SERVICE TRAINING

The contractor shall provide a minimum of eight hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. User Guides shall be provided at the time of this training.

1.08 WIRING

- A. System wiring and equipment installation shall be in accordance with generally accepted engineering best practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall be tested to be free from grounds and shorts.
- B. All system wiring shall be labeled at both ends of the cable. All labeling shall be based on the room numbers as indicated in the architectural graphics package.
- C. Wiring shall be done per manufacturer's recommendation (Category 5/6 or single/multi-pair shielded depending on speaker type. All UTP connections shall be RJ45; all cables connections shall be on screw terminal push-on connectors.

1.09 PROTECTION

- A. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
- B. The contractor shall note on their system drawings, the type and location of these protection devices and all wiring information. Such devices are not to be installed above the ceiling.

1.10 SERVICE AND MAINTENANCE

- A. The contractor shall provide a five-year equipment hardware warranty of the installed system against defects in material and workmanship. All materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on 1st of the month following the date of shipment.
- B. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of this system after the initial hardware and software warranty periods.
- C. System shall include software maintenance that includes bug fixes and new feature releases for a period of six years.
- D. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

PART 2 - SYSTEM SPECIFICATION

2.01 MANUFACTURERS

- A. Manufacturers, subject to compliance with requirements specifications, provide the following system:

Bogen Nyquist E7000MCR Pre-packaged, Rack-Mounted Educational System manufactured by Bogen Communications LLC. The system shall be complete with server, administration PC, and required operating software and licensing.

- 1. Approved Equals: Telecor eSeries

- B. The specifying authority must approve any alternative system 14 days prior to bid day.
- C. The intent is to establish a standard of quality, function, and features. It is the responsibility of the contractor to ensure that the proposed product meets or exceeds every standard set forth in these specifications.
- D. The functions and features specified are vital to the operation of this facility; therefore, inclusion/pre-approval as an alternate manufacturer does not release the contractor from strict compliance with the requirements of this specification.

2.02 EQUIPMENT

- A. Nyquist NQ-E7030 Analog Station Bridge
 - 2. 24 station support
 - 3. 120W of total available power; max. 40W per any individual port
 - 4. 25 Volt Speakers(s)

5. Analog and Digital Call Switch(s)
6. Software programmable configuration and operation
7. Rack mounted, wall mounted, or shelf mounted
8. CAN Bus 2.0 interface for future devices
9. Provide quantity required with a minimum of 15% spare circuits

B. Nyquist NQ-P0100 Matrix Mixer Pre-amplifier

1. No less than four Line/Microphone Level Inputs used for:
 - a. CD Player
 - b. AM/FM Tuner
 - c. Push-to-Talk Paging Microphone
 - d. MP3 Player
 - e. Digital AES/EBU (AES3) input
2. Line Level output to drive external amplifier
3. Software programmable configuration and operation
 - a. Push-to-Talk Channel
 - b. Push-to-Talk Type
 - c. Push-to-Talk Zone
 - d. Mixer Channels
4. Mixer Channels Wall or shelf mounted
5. Provide a quantity of one (1)

C. Nyquist NQ-E7010 Input/Output Controller

1. Eight Dry Contact Inputs
2. Eight Open Collector Outputs
3. Software programmable configuration and operation including:
 - a. Contact Type
 - b. Extension
 - c. Name
 - d. Close Interval
 - e. Actions including:
 - i. Audio
 - ii. Alarm
 - iii. Announcement
 - iv. Disable-Audio
 - v. Other
 - vi. Tone
 - vii. Enable-Audio
 - f. Action ID
 - g. Zones
 - h. Close Extension
 - i. Dashboard Type
 - j. Dashboard Title
 - k. Dashboard Scope
 - l. Dashboard Text
 - m. Dashboard Style

- n. Email
- 4. Provide a quantity of one (1)

D. Miscellaneous Rack Equipment

- 1. Bogen DDU250 Desk Paging Microphone (Qty 1)
- 2. Bogen NQ-Caster1 Free-Standing Rack Caster Kit (Qty 1)
- 3. Grandstream HT813 Telephony FXO/FXS Interface Device for interconnection of District telephone System (Qty 1)
- 4. Cyberpower CP1500PFCRM2U 1500VA Uninterruptable Power Supply (Qty 1)

E. Nyquist Station Equipment (Quantities as required by project plans)

- 1. Bogen NQ-T1100 VoIP Admin Phone – Color Touch Display
- 2. Bogen NQ-T2000 VoIP Admin Phone – LCD Display
- 3. Bogen S86T725PG8U Recessed Ceiling Speaker Assembly with Backbox and Tile Support
- 4. Bogen S86T725PG8U Recessed Ceiling Speaker Assembly with Integral Volume Control, Backbox, and Tile Support
- 5. Bogen CSD2X2U Drop-In Ceiling Speaker
- 6. Bogen MB8TSQ/MB8TSL Surface Ceiling or Surface Wall-Mounted Speaker Assembly
- 7. Bogen AT10A Single-Gang Speaker Volume Control
- 8. Bogen SPT-15A Surface-Mounted Horn Speaker
- 9. Bogen FMH15T Recessed or Surface-Mounted Vandal-Resistant Horn Speaker Assembly
- 10. Bogen NQ-E7020-G2 Digital Call Switch

2.03 SYSTEM CAPABILITIES

- A. The communication system shall be a Bogen Nyquist E7000 Series Educational System and shall provide a comprehensive communications network between administrative areas and staff locations throughout the facility.

The system shall provide no less than the following features and functions:

- 1. Software-based, state-of-the-art, Voice over IP (VoIP) paging and intercom solution.
- 1. The system shall provide a Web User Interface (Web UI) that shall allow users to configure and control the system, in accordance with their assigned User Role, from any Web browser enabled PC, Mac, or Android tablet or mobile device.
- 2. Amplified-voice communication with analog loudspeakers shall use a shielded audio pair when connected to an ASB.
- 3. The system shall support any combination of the following VoIP phone station types: NQ-T1100 Administrative VoIP Phone – Color Touch Display (Admin Station) or NQ-T1000/NQ-T2000 Staff VoIP Phone – LCD Display (Staff Station).

- a. All VoIP phone station types shall utilize the same type of field wiring.
 - b. There shall be no limit to the number of Admin Stations that can be connected to a facility. Systems that require different head-end equipment to make Admin Stations function, or systems that limit the number of Admin or Staff Stations shall not be deemed acceptable.
4. Future station alterations shall only require the Station Type to be changed in system programming. Alterations shall not require field wiring or system head-end alterations, unless an analog station device is being replaced by a VoIP station device or vice-versa.
 5. The system shall be a global non-blocking system. The system shall be capable of unlimited amplified intercom paths per facility. Two amplified intercom paths shall be provided with each ASB for its complement of 24 stations. All hardware, etc., required to achieve the necessary number of amplified-voice intercom channels for this system shall be included in this submittal. ASB amplified-voice intercom channels shall provide voice-activated switching. Systems requiring the use of a push-to-talk switch on administrative telephones shall not be acceptable. There shall be an automatic level control for return speech during amplified-voice communications. The intercom amplifier shall also provide control over the voice switching sensitivity and delay times of the VOX circuitry on the ASB.
 6. The system shall provide 911 Dial-Through via outside FXO/FXS lines or SIP trunks to ensure that one or more lines are always available for 911 calls. The 911 Dial-Through is available to any properly configured station (via CoS). When a station dials 911, the 911 call is processed as follows:
 - a. Call routes to an Emergency Group where the call can be answered.
 - b. The 911 CO lines can be pre-configured and reserved. If the 911 reserved lines are busy, the normal CO lines will be connected to route the 911 calls. If all the normal CO lines are busy, then one of the ongoing calls shall be disconnected and the 911 call shall be placed.
 - c. When 911 is dialed from any station, its designated Admin Station or Admin Group will receive a message that the station has dialed 911.
 - d. The system shall automatically record all 911 calls made from any station. The 911 call recording shall begin as soon as 911 is dialed and shall continue until the call is terminated. Recorded calls shall be maintained on the system for later playback review and/or retrieval by authorized personnel and/or authorities.
 7. It is of highest importance that Emergency Calls from stations receive prompt attention. Therefore, it is important that there be an alternative destination in case the Emergency Call does not get answered at the primary location. Details are as follows:
 - a. Staff-generated Emergency Calls shall be treated as the second highest system priority. Therefore, all Emergency Calls shall annunciate at the top of the call queue of their respective Admin Station or Admin Group. Should that Emergency Call go unanswered

- for 15 seconds, the call shall be re-routed to an alternative speaker station. Then, a tone will prompt the caller to make a verbal call for help and annunciates to the Emergency link station "Emergency." During the transfer, the original administrative telephone shall continue to ring the distinctive Emergency Ring. Should the Emergency Transfer-to-Station have an associated Admin Station, it will also ring for the Emergency Call.
- b. The Emergency Transfer-to-Station shall be software configurable.
 - c. Systems failing to transfer unanswered Emergency Calls or failing to immediately connect to the designated Admin Station shall not be deemed as equal.
8. There shall be a Facility Wide Emergency All-Call feature. The Emergency All-Call shall be accessed from designated Admin Stations or the Nyquist Dashboard or by the activation of an external contact closure that shall give a microphone input Emergency status. The Emergency All-Call function shall have the highest system priority and shall override all other loudspeaker-related functions including Time Tones, Normal All-Call or Zone Pages, or Audio Distribution.
- a. Considering that Emergency Calls are to be treated with the highest level of concern, systems that do not regard Emergency All-Call with the highest priority shall not be deemed as equal.
 - b. Upon touching the Directory icon, a menu shall appear on the Admin Station display prompting the user to select the desired menu.
 - c. The Emergency All-Call shall capture the highest-level system priority and shall be transmitted over all speakers in the facility. It shall also be capable of activating an external control output, which can be used to activate external relays to automatically override volume controls, local sound systems, or strobe circuits.
 - d. Systems without Emergency All-Call or systems with All-Call that cannot be activated by external means or that do not capture complete system priority or activate an external relay, shall not be acceptable.
9. There shall be unlimited Alarm Tones (four by default). Each may be accessed by dialing *91 and the two-digit tone number from any Admin Station, SIP Trunk, or FXO/FXS system interface. These Alarm Tones are separate from the Time Tones. Users shall be able to add an unlimited number of Alarm Tones to the system by uploading MP3 or WAV files. Systems that do not allow the user to upload MP3 and WAV files to customize the Alarm Tones or need to use external alarm/tone generators or special software or have less than four Emergency Alarm Tones shall not be acceptable.
10. Upon touching the Directory icon on an Admin Station, a menu shall appear on the display prompting the user to select from the sub-menus. The Alarms sub-menu is the first available. This precludes the user from having to memorize complicated key sequences to access Alarm Tones.

11. There shall be unlimited I/O Controller relay driver outputs accessible and controllable by properly authorized users via an Administrative Web UI. These outputs remain set until accessed and reset. Users shall have the ability to review the status of each relay driver output. Users shall be prompted through fields via a plain English menu, precluding users from having to remember any dialing sequences to control this feature. The system shall support an unlimited number of I/O Controllers, and each I/O Controller shall be able to interact with any and all other I/O Controllers on the system (i.e., an input on one I/O Controller can trigger an output on one or more different I/O Controllers). Systems that require the user to remember complicated dialing schemes or prompt the user via cryptic commands shall not be acceptable.
 - a. The I/O Controller can create a contact closure when the following operations are performed in the system:
 - i. 911 call placed
 - ii. Audio Distributed
 - iii. Alarm is played
 - iv. Announcement is played
 - v. All-Call preformed
 - vi. District All-Call performed
 - vii. District-Emergency-All-Call
 - viii. Emergency-Call
 - ix. Emergency-All-Call
 - x. Audio-Disabled
 - xi. Page
12. The system shall provide software controlled and programmable control outputs for external relay activation for use with strobe lights, magnetic locks, card access systems, motion detectors, cameras, or any low-voltage, dry contact creating device. Systems using dedicated security stations for control of external functions shall not be acceptable.
13. The system shall be capable of interfacing to PSTN/PBX/IPBX via both FXO/FXS line and SIP trunk connectivity.
14. The system shall be capable of providing each facility (i.e., (i.e., Nyquist location) an unlimited number of incoming FXO/FXS or SIP trunk lines that can be designated by the user to ring the designated Day Admin or Night Admin. Where an Admin Station is designated to receive outside line calls, the incoming call's Caller ID information shall appear on the display. The system shall also provide the ability to make outside line calls from Admin Stations. This ability shall be programmable for each Admin Station and there shall be an unlimited number of CoSs available to assign to any station.
15. The system shall be capable of supporting DID, DISA, and Security DISA functions.
 - a. The system shall provide a password-protected Security DISA feature that shall only be accessible from authorized Police, Fire, Emergency personnel, or an off-premises security office that monitors the facility's security system. The Security DISA feature shall function as follows: Upon dialing the Security DISA phone number, the caller will receive a dial tone from the system, after which he or she must enter the assigned

- Security DISA passcode on the dial pad. Upon confirmation, the system will present the dial tone again and will allow the authorized personnel to dial any station/classroom on the system and monitor the activity without any pre-announce tone or privacy beep. This will allow the authorized personnel to audibly assess the situation and determine what actions need to be taken.
- b. All DISA and Security DISA calls shall be automatically recorded by the system for later playback review and/or retrieval by authorized personnel and/or authorities.
16. The system shall provide for field-programmable three-, four-, five-, or six-digit architectural station numbers.
17. There shall be an automatic level control for return speech during amplified-voice communications.
18. Each station loudspeaker shall be assignable to all or any combination of Paging, Time, and/or Audio Zones. Systems that do not provide unlimited Paging, Time, and/or Audio Zones shall not be acceptable.
19. There shall be unlimited schedules with unlimited programmable events per facility. Each event shall sound one user-selected tone or external audio source. It shall be possible to assign each schedule to a day of the week or to manually change schedules from an authorized user via a web-based UI. Systems that do not provide unlimited schedules, events, and tones, or that require software to be installed on a PC to perform these functions shall not be acceptable.
- a. The system shall provide multiple concurrent schedules per facility/location to accommodate split facilities (for example., combined Elementary and Middle School, combined Middle and High School, etc.).
 - b. The system must be capable of providing Class Change Music to be played from an external audio source or audio files that are stored in playlists on the system during class change periods or whenever a facility wants music to be played in an area (i.e., one or more Time Zones) on an automated schedule.
 - c. Each event shall be able to be directed to any one or more of the unlimited Time Zones.
 - d. Each of the unlimited Time Zones shall have a programmable, customizable Preannounce Tone and volume control that is unique unto itself.
 - e. Each event shall play any of the Normal tones or external audio. Each event may utilize a different tone. For example, the system shall be capable of sending the gymnasium, shop classes, and pool a separate, unique time tone to indicate “clean up.” Minutes later, the entire facility can be sent a different time tone to indicate class change.
 - f. Each of the unlimited Time Tones may be manually activated by selected VoIP Admin Phones or via an authorized user with access to the Web UI. These tones shall remain active as long as the telephone remains off-hook or until canceled from the keypad or the Nyquist Web UI.

1. Systems that do not provide an unlimited number of schedules or do not provide automatic activation of schedules shall not be acceptable.
20. Internal Master Clock shall be included, allowing an unlimited number of events per facility. Systems that do not provide an internal master clock or that must supply an external master clock to meet these specifications shall not be acceptable.
21. The Nyquist E7000 is capable of synchronizing with an NTP server and automatically adjusting the Daylight Savings Time for any time zone in the world. The server that the Nyquist E7000 application is running on can also be used as an NTP server for other systems on the LAN (for example, IP Clocks and control systems).
22. There shall be a Zone Page/All-Call Page feature that is accessible by selected Admin Phones and FXO/FXS or SIP connection to the PSTN or PBX/iPBX.
23. There shall be an option to play a pre-announce tone at any loudspeaker selected for voice paging.
24. There shall be a voice-intercom feature that is accessible by CoS authorized staff phones, all Admin VoIP phones, and Admin Web UIs.
 - a. There shall be a privacy beep played every 15 seconds at any selected loudspeaker to indicate that an intercom call is in progress.
 - b. There shall be a pre-announce tone played at any selected loudspeaker for intercom call communication.
 - c. For special applications, the privacy and pre-announce tone signals shall be capable of being disabled during system initialization.
 - d. There shall be a switch over to private telephone communications should the person at the classroom loudspeaker pick up his or her Staff Station and dial *3 to transfer the call down to the associated classroom Staff Station.
25. There shall be various levels of telephonic communication accessible by all Admin Stations and Staff Stations.
 - a. Staff Stations must be capable of being programmed to ring one Admin Station during day hours and a different Admin Station during night hours. Day and Night start hours shall be configurable. Staff Stations shall be capable of being assigned to any Admin station. Systems that limit the number and assignment of staff call-ins to an Admin Station shall not be acceptable.
26. Each VoIP speaker or ASB speaker equipped with a call switch (analog or digital) shall be configurable as one of three call-in types, as follows:
 - a. Normal/Emergency

- b. Urgent/Emergency
 - c. Emergency
27. Call buttons programmed for access Normal / Emergency or Urgent / Emergency shall be able to initiate an Emergency Call by repeated flashing of the phone's hook switch or repeated pressing of the DCS or the Call Switch. Systems that require additional switches and/or conductors to initiate an Emergency Call, shall not be acceptable.
28. Normal and Urgent Calls shall be placed into the queue for the designated Admin Station or Admin Web UI.
29. Each Admin Station call queue shall first be sorted per call priority (for example, Emergency, then Urgent, and then Normal). Calls are sorted within each priority level on a first-in, first-out basis. When a call is answered, it shall automatically be removed from the queue. Systems that do not sort calls per priority and order received shall not be acceptable.
- a. The display shall simultaneously display a minimum of three intercom calls pending.
 - b. Additional calls beyond three shall be indicated by a scrolling option on the right-hand side of the screen thus prompting the user that additional calls are waiting.
30. It shall be possible to answer any incoming call by picking up the handset while it is ringing. It shall not be necessary to press any buttons to answer a call unless the call has dropped into the queue.
31. Staff Stations
- a. Staff Stations shall receive a dial tone upon going off-hook. Outgoing calls are made by dialing the desired station. Incoming calls can be directed to the telephone or to the associated loudspeaker for a hands-free reply. There shall be a switchover from loudspeaker to private telephone communication when a person picks up the handset, dials *3, and presses Enter/OK.
 - b. Staff Stations shall be programmable for any type of system access, provided by or restricted by the following CoS options:
 - 1. Call-in Level
 - 2. Zone Paging
 - 3. All-Call Paging
 - 4. Emergency All-Call
 - 5. Inter-Facility Call/Page
 - 6. Audio Distribution
 - 7. Remote Pickup
 - 8. Join Conversation
 - 9. Call Forwarding
 - 10. Walking Class of Service
 - 11. External Call Routing
 - 12. Call Transfer/3-way Calling

13. Manually Activate Tone Signals
14. Call Any Station
15. Manage Recordings
16. Monitor Calls
17. Monitor Locations
18. Conference Admin
19. Conference User
20. Voicemail
21. Record Calls
22. Activate Alarm Signals
23. Disable Audio
24. Enable Audio
25. Allow Callee Auto-answer
26. District Paging
27. Inter-Facility Features
28. Manage Output Contacts

- c. Staff Stations shall be able to make a Normal Call to any Admin Station by dialing the Admin Station's extension number. Staff Stations shall also be able to initiate an Emergency Call by dialing ****. Emergency Calls shall ring the Designated Day/Night Admin Station. The system shall provide for each station to have a Personal Identification Number (PIN). By dialing the PIN at any system telephone, the administrator shall have access to Emergency paging regardless of the restrictions on the particular phone being used.

32. Admin Stations

- a. Admin Stations shall receive a dial tone upon going off-hook. Outgoing calls are made by dialing the desired stations. Incoming calls can be directed to the telephone or to the associated loudspeaker for a hands-free reply. There shall be an automatic switchover from loudspeaker to private telephone communication should the person pick up his or her handset.
- b. The display shall normally show the time of day and day of week, bell schedule name, and the numbers of a minimum of three stations calling-in, along with the call-in status of each station (Normal, Urgent, Emergency). The Admin Station's display shall indicate the station number being dialed from the Admin Station.
- c. The display shall also provide user-friendly menu selections to assist the operator when using the Nyquist system. Displays shall be in English for maximum ease-of-use. Systems that require the operator to memorize long lists of operating symbols or control codes shall not be acceptable.
- d. Admin Stations shall be programmable for any type of system access, providing or restricting the following CoS options:
 1. Call-in Level
 2. Zone Paging

3. All-Call Paging
 4. Emergency All-Call
 5. Inter-Facility Call/Page
 6. Audio Distribution
 7. Remote Pickup
 8. Join Conversation
 9. Call Forwarding
 10. Walking Class of Service
 11. External Call Routing
 12. Call Transfer/3-way Calling
 13. Manually Activate Tone Signals
 14. Call Any Station
 15. Manage Recordings
 16. Monitor Calls
 17. Monitor Locations
 18. Conference Admin
 19. Conference User
 20. Voicemail
 21. Record Calls
 22. Activate Alarm Signals
 23. Disable Audio
 24. Enable Audio
 25. Allow Callee Auto-answer
 26. District Paging
 27. Inter-Facility Features
 28. Manage Output Contacts
- e. Program selection and its distribution or cancellation shall be accomplished from a designated Admin Station with the assistance of the menu display system. Distribution and cancellation shall be to any one or combination of speakers, any Audio Zone or Audio Zones, or All Zones. It shall be possible to provide an unlimited number of program channels for the user to pick from.
- f. It shall be possible via an Admin Station to manually initiate any of the unlimited Normal Tones or Emergency Tones. The Tones shall be separate and distinctly different from the Alarm Tones. The Tone selected shall be capable of being played one time, continuously until it is canceled, or until the administrative display phone is placed back on-hook.
- g. Each Admin Station shall maintain a unique queue of all stations calling that Admin VoIP phone.
33. VoIP Wall Baffle and VoIP Ceiling Speakers shall be configurable as one of two station types: 1) VoIP Speaker Only, or 2) VoIP Speaker with DCS.

- a. The Bogen Nyquist VoIP speakers are powered via PoE. Use an 802.3af compliant PoE network switch port or PoE Injector to power these speakers. One PoE network switch port or PoE Injector is required per VoIP speaker.
 - b. VoIP speakers can be equipped with a DCS that can be programmed as a Normal/Emergency, Urgent/Emergency, or Emergency Only and shall be able to initiate an Emergency Call by touching the DCS one, two, or three times depending on the CoS and current call state of the DCS. If the station is authorized for Privacy Mode, the users can touch and hold for 4 seconds to enable Privacy Mode or hold for four seconds to disable Privacy Mode. Systems that require mechanical, membrane, or an additional number of switches to initiate an Emergency Call, shall not be acceptable.
 - c. Emergency Calls from VoIP Speaker with DCS shall have priority over the Normal and Urgent Calls in the queue on the Admin Stations and will show up at the top of the list. Systems that do not provide priority for Emergency Call shall not be acceptable.
 - d. Normal and Urgent Calls shall be logged into queue for the designated Admin Stations.
 - 1. Admin Stations shall ring for when they receive a call, and then the call will be removed from the queue when the call is answered or when the Admin Queue times out (default is 30 minutes).
 - e. Each queue call shall first be sorted by call priority (Emergency, then Urgent, and then Normal). Calls are sorted within each priority level on a first-in, first-out basis. When a call is answered, it shall automatically be removed from the queue. Systems that do not sort calls by priority and order received, shall not be acceptable. The display shall simultaneously show a minimum of three staff calls pending. Additional staff calls beyond three shall be indicated by an arrow pointing down thus prompting the Admin user that additional calls are waiting.
 - f. It shall be possible to answer any incoming call simply by picking up the handset while it is ringing. It shall not be necessary to hit any buttons to answer a call unless the call has dropped into the queue.
34. System programming shall be from an authorized Nyquist Admin User via any web browser. A valid username and password shall be required to gain access to the following programmable functions:
- a. System Parameters – Allow installers to adjust core system parameters.
 - b. Zones – Allow installers to create and modify Paging, Time, and Audio Zones.
 - c. Schedules – Allow installers and administrators to create Bell Schedules for the facility, predefine alternative schedules to run. Holiday Events prevent the bells from ringing on a school holiday. The system shall allow an unlimited number of schedules to operate simultaneous within a facility.
 - d. Admin Groups – Allow the installer to create, modify, and delete software groupings of admin phones that can ring when a station calls in with a call switch.

- e. CoS Configuration – Allow the installer to create, modify, and delete CoS groups that can have the following features defined: Call in Level, Zone Paging, All-Call Paging, Emergency All-Call, Inter-Facility Call/Page, Audio Distribution, Remote Pickup, Join Conversation, Call Forwarding, Walking Class of Service, External Call Routing, Call Transfer/3-way Calling, Manually Activate Tone Signals, Call any Station, Manage Recording, Monitor Calls, Monitor Locations, Conference Admin, Conference User, Voicemail, Record Calls, Activate Alarm Signals, Disable Audio, Enable Audio, Allow Callee Auto-answer, District Paging, and Inter-Facility Features.
- f. Stations – Allow the installer to set up, modify, delete stations, set up Page Exclusion, view stations' status, and add a station.
- g. Bridge Devices – Allow the installer to install the Nyquist ASBs.
- h. Audio – Allow the installer to upload and manage Announcements, Playlists, Announcements, Songs, and Tones. The must support the uploading of both MP3 and WAV files making Audio file management simple for users. Systems that limit the size of Audio files shall not be considered equal.
- i. Users – Allow the installer to manage users by giving them the proper Role and assign an Extension if needed.
- j. Roles – Allow the installer to limit user to the following: create, delete, edit, restart server, sort menu, systems update, manage, import/export, restore, settings, or view.
- k. Facilities – Allow the installer to set up the district wide facilities for remote paging and calling.
- l. Outside Line – allow the installer to set up FXS and FXO ports for inbound and outbound system calling.
- m. SIP Trunks – allow the installer to set up SIP trunks into the facility for inbound or outbound calling.
- n. Call Details – allow the installer to review the historical system activities that can be used for incident investigation or system troubleshooting.
- o. System Backup/Restore – allow the installer to preform system backup or restores and allow the backups to be schedule to run automatically.
- p. System Logs – allow the installer to view and export Server, Nyquist-Intercom, and Web Server logs that can be used for trouble shooting and technical assistance.
- q. Paging Exclusions – allow the installer to view and edit station that are excluded from paging.
- r. Firmware – is used to update Nyquist appliances.
- s. Help –Provides information about the system, online help topics, and System Administrator Manual.
- t. Systems not capable of supporting web-based configuration and control, or require plugins or dedicated application software, shall not be deemed as equal.
- u. Systems that require a Serial-to-Ethernet converter, or require additional application software on a PC for configuration and/or control shall not be deemed as equal.

35. Admin Group

- a. Admin Stations can be placed into Admin Groups, which are used if incoming calls are not answered by the assigned Admin Station or the Day or Night Admin associated with the Admin Station. Admin Groups act as an always answer feature by providing an alternate list of Admin Stations. If an incoming call is not answered by the assigned

Admin Station within 30 seconds for normal calls or 15 seconds for emergency calls, all Admin Stations in the Admin Group will ring.

- b. If Call Forwarding is enabled at the Admin Station, Nyquist tries the forwarded extension. If that station does not answer or is busy, the call timeout is reduced to 15 seconds. After 15 seconds, the call rolls over to the Admin Group.
- c. If an Emergency level call receives no answer, the Admin Group will ring if the Day Admin or Night Admin does not answer.
- d. Admin Stations can be assigned to multiple Admin Groups. A Day or Night Admin can also be assigned to one or more Admin Groups.

36. Call Detail Reporting

- a. The Call Details feature allows the viewing and/or printing of detail records of every call in a facility in a call log format. Calls include scheduled announcements, paging, and internally and externally made or received telephone calls.

37. System Backup/Restore

- a. The system backup feature allows users with access to back up the system database, voicemail, and recordings.
- b. The system restore allows users with access to perform a system restore of previously backed up database, voicemail, and/or recordings.
- c. The installer also can set up an automatic backup that can be performed daily, weekly, or monthly.

38. System Log Files

- a. A log file records either events or messages that occur when software runs and is used when troubleshooting the system. The following parts of the Nyquist system generate log files:
 - i. Server (This provides access to the Debian Linux OS server log files.)
 - ii. Intercom (This provides access to the Intercom application server log files.)
 - iii. Web Server (This provides access to the web server log files.)
- b. From the web-based UI, system logs can be viewed directly or exported via download to a PC, Mac, or Android device and then copied to removable media or attached to an email to technical support.

39. Paging Exclusions

- a. For school testing and exams, the administrators shall be able to put stations into Page Exclusion mode. During this time, the stations will only receive Emergency All-Call

pages – not music, tones, or All-Calls. Emergency pages will still be heard at the station even if that station is set to exclude paging.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with the installer present, for compliance with requirements and other conditions affecting the performance of the Nyquist E7000 Series Educational System.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.02 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- A. All work described herein to be done by the manufacturer's authorized representative shall be provided by a documented factory authorized representative of the basic line of equipment to be utilized. The District's current Bogen Representative is Intellicom Systems Incorporated, 856-665-5366.
- B. The manufacturer's representative shall have completed at least 10 projects of equal scope, giving satisfactory performance, and shall have been in the business of furnishing and installing sound systems of this type for at least five years. The manufacturer's representative shall be capable of being bonded to ensure the owner of performance and satisfactory service during the guarantee period.
- C. The manufacturer's representative shall provide a letter with submittals from the manufacturer of all major equipment stating that the manufacturer's representative is an authorized distributor. This letter shall also state that the manufacturer guarantees service performance for the life of the equipment and that there will always be an authorized distributor assigned to service the area in which the system has been installed.
- D. The contractor shall furnish a letter from the manufacturer of the equipment. This letter shall certify that the equipment has been installed according to factory intended practices, that all the components used in the system are compatible, and that all new portions of the systems are operating satisfactorily. Further, the contractor shall furnish a written unconditional guarantee, guaranteeing all parts and all labor for a period of five years after final acceptance of the project by the owner.

3.03 DIVISION OF WORK

- A. While all work included under this specification is the complete responsibility of the contractor, the following division of actual work listed shall occur:
 - 1. The conduit, outlets, terminal cabinets, etc., which form part of the rough-in work, shall be furnished and installed completely by the electrical contractor.

2. The balance of the system, including installation of speakers and equipment, making all connections, etc., shall be performed by the manufacturer's authorized representative. The entire responsibility of the system, its operation, function, testing and complete maintenance for one year after final acceptance of the project by the owner, shall also be the responsibility of the manufacturer's authorized representative.

3.04 INSTALLATION

- A. The installation, adjustment, testing, and final connection of all conduit, wiring, boxes, cabinets, etc., shall conform to local electrical requirements and shall be sized and installed in accordance with the manufacturer's approved shop drawings.
- B. Low-voltage wiring may be run exposed above ceiling areas where they are easily accessible.
- C. The contractor shall install the new system at the location shown on the plans.
- D. Volume controls and call switches shall be wall-mounted:
 1. Mount at 54" AFF.
 2. All wiring should be concealed.
 3. Verify exact location with architect.
 4. Avoid mounting near doors to prevent students from activating and running out of the rooms.
- E. Admin Stations can be desk or wall mounted.
- F. Speaker and telephone lines run above ceiling and not in conduit shall be tie-wrapped to a ceiling joist with a maximum spacing of 8' between supports. No wires shall be laid on top of ceiling tile.
- G. Connect field cable to each Analog Speaker transformer using UL butt splices for #22 AWG wire.
- H. Contractor shall provide a minimum of eight hours of configuration and operational instruction to school personnel.
- I. Miscellaneous speaker installation guidelines (unless indicated otherwise on project plans):
 1. All outside speakers shall be on a separate Page Zone and Time Zone.
 2. All zones shall be laid out not to exceed 40 Watts @ 25V maximum per zone.
 3. All hallway speakers shall be tapped at 1 Watt @ 25V.
 4. All outside horns shall be tapped at 3.75 Watts @ 25V.
 5. All classroom speakers shall be tapped at ½ Watt @ 25V.
 6. Large rooms, such as cafeterias, shall be tapped at 2 Watts @ 25V.
- L. Plug disconnect: All major equipment components shall be fully pluggable by means of multi-pin receptacles and matching plugs to provide for ease of maintenance and service.

- M. Protection of cables: Cables within terminal cabinets, equipment racks, etc., shall be grouped and bundled with T and B wire-ties, or hook and loop cable management. Edge protection material shall be installed on edges of holes, lips of ducts, or any other point where cables or harnesses cross a metallic edge.
- N. Cable identification: Cable conductors shall be color-coded and individual cables shall be individually identified. Each cable identification shall have a unique number located approximately 1-1/2" from cable connection at both ends of cable. Numbers shall be approximately 1/4" in height. These unique numbers shall appear on the As-Built Drawings.
- O. Shielding: Cable shielding shall be capable of being connected to common ground at point of lowest audio level and shall be free from ground at any other point. Cable shields shall be terminated in the same manner as conductors.
- P. Provide complete "in service" instructions of system operation to school personnel. Assist in programming of telephone system.

3.05 GROUNDING

- A. The contractor shall provide equipment grounding connections for Integrated Telecommunications/Time/Audio/Media System as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to ensure permanent and effective grounds.
- B. The contractor shall provide ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- C. The contractor shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
- D. The contractor shall note on their drawings the type and locations of these protection devices and all wiring information.
- E. The contractor shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground buss bar.

3.06 DOCUMENTATION

Provide the following directly to the Supervisor of Technology Services.

- A. One printed copy of all field programming for all components in system
- B. One copy of all diagnostic software with a copy of field programming data for each unit

C. One copy of all field wiring runs, location, and end designation of system

END OF SECTION 275134

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SECTION 275139 – CELLULAR DISTRIBUTED ANTENNA SYSTEM SURVEY (ADDENDUM 3)

PART 1 – GENERAL

1.1 GENERAL:

- A. The purpose of this specification is to establish the requirements and standards for initial survey for a complete passive cellular distributed antenna system that is capable of working with all large carriers.
- B. Survey should be performed after the building is substantially completed, and prior to start of installation of electrical wiring.
- C. Conduct a survey using a RF Spectrum Analyzer, a calibrated, system-compatible radio or another suitable instrument with traceable certificate of calibration to analyze the RF signal strength of Cellular Signal into the building and determine if amplification of the signal is required. Both inbound and outbound signal strength shall be determined, measured, calculated and documented.

1.2 SIGNAL STRENGTH:

- A. The in-building cellular system is an integral component of the life safety equipment of a building or structure. The primary function is to test for reliable communications to an outside source at the required signal strength within the specified areas.
- B. Critical Areas such as emergency command center, fire pump room, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and similar critical areas shall be provided with 100% floor area radio coverage.
- C. General building areas shall be tested for 95% radio coverage.
- D. In-building cellular systems must test for the following signal strengths:
 - 1. Downlink - Minimum signal strength of -95 dBm throughout the coverage area.
 - 2. Uplink - Minimum signal strength of -95 dBm received at the Signal Booster.

1.3 RADIO SIGNAL STRENGTH SURVEY:

- A. The contractor shall have the in-building system tested to ensure that cellular coverage on each floor of the building meets or exceeds the required levels. Building must be completed with all walls, windows, roof, interior partitions completed prior to the survey.
- B. Each floor of the building shall be divided into a grid of a minimum of twenty (20) equal

areas of no larger than 2,500 SF each. Each critical area shall contain at least one test reading. Maximum of one (1) test point of general area will be allowed to fail the test per floor. A 100% of all critical areas must pass. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Field strength testing instruments are to be recently calibrated (1 year) and of the frequency selective type incorporating a flexible antenna similar to the ones used on the hand-held transceivers.

- C. RF plots indicating the enhanced coverage shall be submitted at the time of acceptance testing.

END OF SECTION 275139

SECTION 275139 – CELLULAR DISTRIBUTED ANTENNA SYSTEM SURVEY (Addendum 3)

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- C. RF plots indicating the enhanced coverage shall be submitted at the time of acceptance testing.

END OF SECTION 275139

SECTION 275313 – WIRELESS CLOCK SYSTEM

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS & SCOPE

- A. Furnish and install a complete new wireless clock system using Telecor Inc. wireless system.
- B. All bids shall be based on the equipment as specified herein. The catalog numbers and model designations are that of Telecor Inc. The specifying authority must approve any alternate system.
- C. Bidders wishing to submit alternate equipment shall submit to the specifying authority, at least ten (10) days prior to bid opening, the equipment proposed to provide a precise functional equivalent system to meet specifications. Bidder shall provide adequate information prior to bid date such as specification sheets, working drawings, shop drawings, and a demonstration of the system. Alternate supplier-contractor must also provide a list to include six (6) installations of the identical system proposed which have been in operation for a period of two (2) years.
- D. Final approval of the alternate system shall be determined at the time of job completion. Failure to provide the “precise functional equivalent” shall result in the removal of the alternate system at the contractor’s expense.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract apply to this Section.
- B. Requirements of the following apply to this Section:
 - 1. Basic Electrical Requirements
 - 2. Basic Electrical Materials and Methods

1.3 SUMMARY

- A. This Section addresses the needs and requirements of the wireless clock system. It includes requirements for the wireless clock system components including, but not limited to, the following:
 - 1. Wireless Transceiver
 - 2. Wireless Repeater
 - 3. Secondary Analog Clock

1.4 SYSTEM DESCRIPTION

- A. General: Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating wireless clock system.

1.5 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract
- B. Sections:
 - 1. Submit equipment prints, full electronic wiring diagrams and specifications sheets for each item specified herein. Provide a tabulation of the specification clearly comparing the submitted item with the specified item, being able to refer to all written expressed functions and capabilities. Specification sheets shall be submitted on all items.
 - a. Shop drawings detailing wireless clock
 - 2. Wiring diagrams, detailing wiring for power, signal, and control.
 - 3. Submit wiring diagrams showing typical connections for all equipment.
 - 4. Submit a certificate of completion of installation and service training.

1.6 QUALITY ASSURANCE

- A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.
- B. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least three (3) years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full manufacturer's warranty privileges.
- C. The contractor shall show satisfactory evidence, upon request, that the supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The supplier shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.
- D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to:
 - 1. Article 250, Grounding.
 - 2. Article 300, Part A. Wiring Method.
 - 3. Article 310, Conductors for General Wiring.
 - 4. Article 725, Remote Control, Signaling Circuits.
 - 5. Article 800, Communication Systems.

- E. Installation and start up of all systems shall be under the direct supervision of a local agency regularly engaged in installation, repair, and maintenance of such systems. The supplier shall be accredited by the proposed equipment manufacturers.
- F. The agency providing equipment shall be responsible for providing all specified equipment and mentioned services for all equipment as specified herein. The agency must be a local authorized distributor of all specified equipment for single source of responsibility and shall provide documents proving such. The agency must provide written proof that the agency is adequately staffed with factory-trained technicians for all of the specified equipment. The agency must have established business for and currently be providing all services for the equipment.
- G. The contractor shall guarantee availability of local service by factory-trained personnel of all specified equipment from an authorized distributor of all equipment specified under this section. Maintenance shall be provided at no cost to the purchaser for a period of one (1) year (parts and labor) from date of acceptance unless damage or failure is caused by misuse, abuse, neglect, or accident. Additionally, all manufacturer supplied products must be covered by three (3) year (parts only) limited warranty from the date of acceptance. The warranty period shall begin on the date of purchase by the owner/engineer.
- H. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of the system after the initial warranty period.
- I. The supplier shall visit the sites and familiarize himself with the existing conditions and field requirements prior to submitting a proposal.
- J. The contractor is responsible for all cost associated with proper installation, termination, configuration, programming, impedance and load matching of all system components.
- K. The contractor shall provide all necessary masonry, covering, patching, and painting work in order to render any residue of the existing central equipment invisible. All finished surfaces shall be chosen in consultation with the Owner, to assure that the Owner's aesthetic preferences have been adhered to.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in factory boxes. Store in clean, dry space in original boxes. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.8 IN-SERVICE TRAINING

- A. The contractor shall provide training with this system. These sessions shall be broken into segments that will facilitate the training of individuals in the operation of this system. Operators Manuals and Users Guides shall be provided at the time of this training.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. The manufacturer shall be:
Telecor Inc. 6205 Kestrel Road, Mississauga, Ontario, L5T 2A1
www.telecor.com
- B. The new wireless clock systems shall each be a Telecor Wireless Clock System.
- C. The intent of this specification is to establish a standard of quality, function and features. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications.
- D. The functions and features specified are vital to the operation of this facility, therefore, the acceptance of alternate manufacturers does not release the contractor from strict compliance with the requirements of this specification.
- E. The Contractor for this work shall be held to have read all of the Bidding Requirements, the General Requirements, and Contract Proposal Forms; and in the execution of this work, he will be bound by all of the conditions and requirements therein.
- F. The contractor shall be responsible for providing a complete functional system including all necessary components whether included in this specification or not.
- G. In preparing the bid, the bidder should consider the following:
 - 1. No claim will be made against the owner for any costs incurred by the bidder for any equipment demonstrations which the owner requests.
- H. Any prior approval of an alternate system does not automatically exempt the supplier from the intent of these specifications. Failure to comply with the operational and functional intent of these specifications may result in the total removal of the alternate system at the expense of the contractor.
- I. Alternate equipment shall be considered if submitted to the specifying authority at least ten (10) days prior to bid date. Submission of an alternate shall contain an original draft point by point comparison of the submitted product relative to the requirements of this specification, engineering drawings of the system, and specification sheets covering all components of the system as well as all items of Section 1 “SUBMITTALS”. The system and equipment drawings and specification sheet shall meet all items of the specification.
- J. Proposed alternate equipment shall be accompanied by a letter from the manufacturer clearly stating that they have read the specifications, have listed differences between their product and the specified product, and commit to meet or exceed the specified requirements herein.

- K. All proposed alternate systems must comply with Section 2.1, letters H and I above. Submissions failing to comply with the aforementioned requirement shall be deemed as non-compliant.

2.2 SYSTEM REQUIREMENTS

- A. Wireless analog clock system with interface capability to eSeries Intercom and Paging System.

2.3 SYSTEM

- A. The system can operate as a stand alone system or in conjunction with an eSeries Intercom and Paging System. The system shall have interface capability to GPS, network, Internet and existing clocks systems such as 58 minute, 59 minute, sync-wire secondary analog clocks.
- B. The system shall be designed to work in an environment where cabling options are not available. The system shall be capable of working in 915-928 MHz frequency-hopping technology. The system shall be capable of automatic transmission of data along 51 alternating frequencies that allows for an enhanced signal, even if there is interference in one of the frequencies.
- C. Each clock in the system shall be capable of receiving and transmitting the wireless signal which allows it to be used as a repeater while boosting the data stream and sending along the system. With this dual capability there shall be no limit on the number of clocks that can be used in the installation. The clock shall be designed to automatically work together without interference with each other. The system shall be capable of increasing the quality of the signal while increasing the quantity of the clocks.
- D. The analog clocks shall be capable of working in one (1) of the following options
 1. Two (2) D cell batteries; the clock receives and transmits time every four (4) hours.
 2. 110 volts AC; the clock receives and transmits time every one (1) minute.
 3. 24 volts AC/DC; the clock receives and transmits time every one (1) minute.
- E. The analog clock shall include automatic digital calibration for time base to minimize deviation from each other.
- F. The analog clock shall have a built-in close-loop system that will allow the clock to detect the position of the hands and bring the clock to the right time even if the clock were manually or forcefully altered.
- G. The analog clock shall have the capability for diagnostic function that will allow the user to view the quality of the signal, how long since the last time the clock received a signal, as well as functional tests of the electronics and the gears.

- H. The system shall operate in a license-free frequency range where no license is required.

2.4 FCC APPROVAL

- A. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
1. Reorient or relocate the receiving antenna.
 2. Increase the separation between the equipment and receiver.
 3. Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
 4. Consult the dealer or an experienced radio/TV technician.

2.5 PRODUCT

A. Transmitter/Transceiver

1. The Master Clock / Transmitter shall be the Telecor Model 2490 Transceiver. The transmitter shall be capable of transmitting data to the Telecor wireless analog clock clock. The transmitter shall be capable of receiving a signal from an atomic clock web site via the Internet. The transmitter will be capable of receiving correction from all Telecor Master Clocks, as well as 59 minute correction, 58 minute correction, National Time and Rauland, and Dukane. The transmitter shall have a programmable auxiliary relay and shall be programmed anywhere from 1—99 seconds. Upon utilization of the relay, the transmitter will be capable of interfacing with a once a day closure or interfacing with intercom systems. The transmitter shall be capable of acting as a repeater while receiving a signal wired or wirelessly from the main transmitter. The time base shall be temperature controlled allowing calibration of the time base during temperature changes. The transmitter will have two (2) switches for operation of the menu system. The transmitter shall utilize 915–928 MHz frequency-hopping technology. The transmitter shall be FCC compliant, part 15 Section 15.247.

B. Repeater

1. The repeater shall be a Telecor Wireless Repeater. The repeater shall wirelessly transmit and receive data. The repeater shall be capable of transmitting to the Telecor wireless analog clock. The repeater shall work on 915–928 MHz frequency–hopping technology. The repeater shall wirelessly transmit and receive data. The repeater is to have a maximum antenna size of seven (7) inches. The repeater shall have an RF input sensitivity of –103 dbm. The repeater is to have a RF power output of 27 dbm. The voltage input for the repeater shall be 110 volts/60 Hz or 220 volts/50 Hz. The repeater shall have three (3) knockouts with a diameter of 7/8". The case shall be a compact, smooth surface metal enclosure. The repeater is to weigh 3.5 pounds. The repeater shall be FCC Compliant, part 15 Section 15.247.

C. Analog Clock

1. The secondary clock shall be Telecor 2490 Series wireless clock. The clock will be capable of receiving a signal from multiple clocks. The clock shall receive and transmit with 915–928 MHz frequency–hopping technology. The clock is to be capable of transmitting the time simultaneously without interfering with each other. The clocks shall include automatic calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, a gearbox test and a comprehensive analysis of the entire clock. The clock shall have a maximum correction time of five (5) minutes. It shall be designed to be used with the Telecor Transceiver or the Telecor Repeater, which can be regulated via Telecor wireless communication protocol. Upon receipt of the wireless signal, the clock will immediately self–correct. The clock shall have a semi–flush smooth surface ABS case. The dial is to be made of durable polystyrene material. The crystal is to be shatterproof, side molded polycarbonate. Glass and visible molding marks are unacceptable. The clock shall have black hour and minute hands as well as a red second hand. The clock shall be FCC compliant, part 15 Section 15.247.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the wireless clock system.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Install system in accordance with applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. Wiring Methods:

1. Conceal wiring except in unfinished spaces.
2. All new wiring on this project must be properly rated for the application.
3. Cable to the new devices at new locations shall be installed in a neat and workmanlike manner, following the standard procedures used in the electrical contracting trade.
4. Exposed wiring will not be permitted under any circumstances on this project.
5. Any wiring, which is considered sloppy by the Engineer, shall be strictly unacceptable.
6. Upon installation completion, a room-by-room test shall be conducted for every device in the system. A technician shall perform the test after school hours, and repairs shall be performed as needed at no cost to the Owner to any devices, which do not function correctly, including cable. A written room-by-room report following testing and repairs shall be prepared and submitted to the Engineer.

3.3 FIELD QUALITY CONTROL

A. Contractor Field Service:

1. Provide services of a service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection

1. Make observations to verify that units and controls are properly labeled.

C. Testing:

1. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at the Contractor's expense. Verify by the system test that the total system meets the specifications and complies with applicable standards.

3.4 COMMISSIONING

- A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Operators Manuals and Users Guides shall be provided at the time of this training.
- B. Schedule training with Owner through the Architect, with at least seven (7) days advance notice.

3.5 CLEANING AND PROTECTION

- A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 275313

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SECTION 27 6000 – CAFETERIA / GYM SOUND SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The Electrical Contractor, as part of this section, shall provide, install and test a complete sound reinforcement system as specified herein for areas indicated on the drawings.
- B. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the sound reinforcement system.

1.2 SUBMITTALS

- A. Submit the following in accordance with Conditions of Contracts and Division 1 specifications sections:
 - 1. Audio functional
 - 2. Rack elevations
 - 3. Loudspeaker mounting details
 - 4. Conduit riser
 - 5. AV plate details
 - 6. Cable pull schedule
 - 7. Manufacturer equipment specification sheets

1.3 QUALIFICATIONS OF BIDDERS

- A. The bidder shall be a firm with a minimum of 5 years of experience in the fabrication, assembly, and installation of audio systems of similar magnitude and quality as specified in these documents, and shall submit documentation to this effect with the bid return.
- B. The bidder shall be I.C.I.A / A.V.S.P certified.

1.4 ALTERNATE EQUIPMENT

- A. This equipment was selected to establish a standard of quality and performance. The contractor may offer substitutes for approval but the burden of proof of equality shall be with the contractor.
- B. Pre-approval submittals shall contain a component-by-component comparison of all specification lines. Differences shall be clearly high-lited with the explanation and support data. Connection drawings shall also be provided to establish how the substituted components will achieve the specified system design

- C. The contractor shall provide any additional documentation, samples, or performance tests required by the Engineer in order to establish proof of equality with the specified equipment.
- D. All substitutions shall provide equal or greater system performance and function. No substitute equipment shall be purchased or installed without approval by the Engineer.
- E. Final approval of the substituted equipment shall be given after the system has been installed. Failure to meet the specification, as determined by the Engineer, shall result in the removal of the substituted equipment and the installation of the specified equipment without any additional cost to the owner.
- F. When a piece of specified equipment has been discontinued by the manufacturer or is unavailable due to lack of inventory, the contractor may substitute the manufacturer's recommended replacement without notice to the Engineer. If a piece of equipment is not replaced by a newer model with the same or better features and a different manufacturer can supply a piece of equipment that meets or exceeds the original equipment, the contractor shall notify the Engineer and submit the equipment cut sheets for approval.

1.5 EXCEPTIONS

- A. Any and all exceptions to these specifications and related drawings must be made with the submission of the bid. In the absence of exceptions, the specifications and related drawings shall be binding in letter and intent on the successful bidder. It will also be understood that the bidder has examined the design and specifications in detail, and is prepared to take full responsibility for the performance of the complete installation as designed and specified.

1.6 SUB-CONTRACT INFORMATION

- A. Any and all sub-contractors that a bidder plans to utilize for this project are to be listed with the references and qualifications in the bid submission. The successful bidder shall supervise all sub-contract work. Any and all sub-contract work is the complete and sole responsibility of the contractor.

1.7 SPECIFICATION INFORMATION REQUESTS AND QUESTIONS

- A. Any requests for clarification shall be submitted to Mr. DJ Seibert of Snyder Hoffman Associates, 1005 West Lehigh Street, Bethlehem, PA, 18018, 610-694-8020, dseibert@snyderhoffman.com. All requests are to be made in writing and submitted no later than ten days prior to bid submission.

1.8 CERTIFICATIONS AND REPRESENTATIONS

- A. Quality of materials: All equipment items and installation materials will be new. No previously owned, demonstrated or otherwise used items will be provided. Note that prior to equipment installation and on-site integration, all equipment items shall be performance tested and quality checked to insure full functionality of each equipment item.
- B. Tax Statement Certification: The contractor certifies that all local, state, and federal taxes are separately listed in any price quotations.

1.9 QUALITY ASSURANCE

- A. All equipment and materials provided for this contract are to be new and shall meet or exceed the latest published specification of the manufacturer for that item.
- B. All equipment shall be UL listed or equivalent.

1.10 NOT IN CONTRACT

- A. Some equipment related to the audio system will be provided under the Electrical Contract. Unless otherwise indicated in these specifications or related drawings, these will include the following:
 - 1. All electrical breaker / load panels.

PART 2 PRODUCTS

2.1 EQUIPMENT DESCRIPTION

- A. System Electronics:
 - 1. The Cafeteria/Gym/Stage shall be provided with a complete locally controllable audio system. All equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electronically whether or not those specifications are delineated herein. The manufacturer's latest published specifications shall be considered as part of this text. Quantities are shown on the Contract Documents.
 - 2. Provide Biamp Tesira Server-IO or equal. The configurable I/O DSP shall be designed exclusively for use with Tesira® systems. The configurable I/O DSP shall support AVB digital audio and control networking by means of a modular 420 x 420 channel card. The configurable I/O DSP shall also support use of one or two 32 x 32 channel CobraNet® digital networking cards and/or one or two 64 x 64 channel Dante™ digital networking cards, up to a maximum of three audio networking cards total per chassis.

The configurable I/O DSP shall be factory configured with one DSP card and shall be capable of supporting a total of three cards.

The configurable I/O DSP shall provide dual Ethernet ports for configuration and control connection. The configurable I/O DSP shall support port authentication via IEEE 802.1X. The configurable I/O DSP shall be configurable for up to 48 channels of local audio input and output, including mic and line level, VoIP, and standard telephone interface. The configurable I/O DSP shall also support modular I/O cards for acoustic echo cancellation and ambient noise compensation.

The configurable I/O DSP shall provide front panel LED identification of device power, status, alarm, and activity as well as system-wide alarm. The configurable I/O DSP shall provide front panel OLED display for device and system information. The configurable I/O DSP shall be rack mountable (3RU) and feature software-configurable signal processing, including but not limited to: signal routing and mixing, equalization, filtering, dynamics, and delay, as well as control, monitoring, and diagnostic tools.

The configurable I/O DSP shall be CE marked, UL listed and shall be compliant with the RoHS directive. Warranty shall be five years.

3. ***Provide Crown CDi 2000 audio amplifier or equal.*** The amplifier shall feature: Channels-2, Sensitivity (for full rated power at 8 ohms)-1.4V, Rated Power Output (per channel @ 4 ohms)-800W Stereo, Signal to Noise Ratio (below rated 1 kHz power at 8 ohms)-100 dB (A-weighted), THD - < 0.5%, Damping Factor (20 Hz to 400 Hz) - > 500, Frequency Response (at 1W, 20 Hz - 20 kHz) - + 0 dB, -1 dB, Crosstalk (below rated power) 20 Hz to 1 kHz - >70 dB, Input Impedance (nominal) - 20k ohms balanced, 10k ohms unbalanced.

Dimensions - 3.5" x 19" x 12.25", Weight - 22.0 lbs, IEC Power Connector- 15A.

Provide Crown CDi 2/300 audio amplifier or equal. The amplifier shall feature: BLU link-No, Channels-2, Sensitivity (for full rated power at 8 ohms) - 0.7V RMS, Rated Power Output (per channel @ 4 ohms) - 300W, Analog Input Signal to Noise Ratio (ref. rated power, 100V, 20Hz - 20kHz) at 8 ohms) > 104dB, THD (full rated power, 20 Hz - 20 kHz) - 0.35%, Damping Factor (20 Hz to 100 Hz) > 1000, Frequency Response (8Ω, 20 Hz - 20 kHz) +/-0.5dB, Crosstalk (below rated power) 20 Hz to 1 kHz > 80dB, Input Impedance (nominally balanced, nominally unbalanced) - 20 kΩ balanced, 10 kΩ unbalanced.

Dimensions (inches) (W x H x D) (depth not including 1.3 inch front panel protrusion) 19 x 3.5 x 12.25, Weight 14.56 lbs (6.6 kg), Power Supply Connector - Standard IEC type 320 inlet for detachable connector 100 – 240V~

4. SPEAKERS:

Provide Soundtube HP1290i or equal. The loudspeaker shall consist of one 305 mm (12.0 in.) low-frequency transducer and one 35 mm (1.375 in.) high-frequency transducer with a frequency-dividing network installed in a ported enclosure. The low-frequency voice coil diameter shall be 50 mm (2.0 in.).

Performance specifications of a typical production unit shall be as follows: Useable frequency range shall extend from 59 Hz - 22 kHz, -10 dB. The loudspeaker shall be available with selectable 25/70.7/100-volt tap switch with transformer bypass position. The frequency-dividing network shall have a crossover frequency of 2.2 kHz. Rated power capacity of the components and network shall be at least 150 watts continuous (RMS) and conform to EIA-426-B testing. Maximum continuous output at 1 meter shall be at least 118 dB.

The low-frequency transducer shall have treated fiber cone material with a treated cloth surround. The high-frequency transducer shall be constructed of Mylar material.

Installation for the speaker shall be by galvanized steel cable affixed to the speaker chassis via an integrated snap hook. For safety redundancy, a secondary steel cable shall be included. The external wiring input connector shall be a four-pin, 5.08 mm Euroblock for 8 ohm or distributed systems and shall accept 10-22-gauge wire. The unit shall be for indoor and outdoor applications and have a weather-resistant boot covering all wire connections. The system shall ship complete with hanging hardware including hanging and safety cables, Euroblock connector and terminal weather boot. The speaker has an optional surface mount bracket (AC-RS-SM1290)

The ported enclosure shall be constructed from injection-molded, glass-reinforced ABS with a total volume of 2 cubic feet. The grille shall be constructed of powder-coated steel and affix to the speaker via friction fit with two blind-mounted, radial screws.

The unit is factory preset to the 150-watt setting in the 70.7-volt operating mode, with a tap switch located on the front baffle of the speaker, accessible by a removable grille plug. Signal input shall be by four-pin Euroblock connector, which accepts up to 10-gauge wire.

Provide JBL Control 25-1 loudspeakers or equal. The loudspeakers shall feature Frequency Range: 60 Hz – 20 kHz, Frequency Response: 85 Hz – 17 kHz, Power Rating2: 200W Continuous Program (2 hrs), 100W (400W peak) Continuous Pink Noise (2 hrs), 75W (300W peak) Continuous Pink Noise (100 hrs), Maximum Input Voltage 25.3 V RMS (2 hrs), 50.6 V peak, Maximum SPL: 110 dB average Continuous Pink Noise (116 dB peak), Sensitivity4: 90 dB, 1W/1m (averaged 100 Hz – 10 kHz), Coverage Angle: 100° x 100°, Directivity Factor (Q): 6.04 (averaged 1 kHz – 16 kHz), Directivity Index (DI): 7.6 dB (averaged 1 kHz – 16 kHz), Nominal

Impedance: 8 ohms (THRU setting), Crossover Type: 2nd order low-pass, 3rd order high-pass.

Circuitry; Transformer Taps: 70V: 30W, 15W, 7.5W, 3.7W, 100V: 30W, 15W, 7.5W, Insertion Loss <0.94 dB at any tap setting, Thru Setting: 8Ω nominal.
Recommended Protective High-Pass: 60 Hz high-pass (24 dB/oct) (for 8Ω operation and for all 70V/100V tap settings) Transducers; Low Frequency: 135 mm (5.25 in), woven-fiberglass cone with pure butyl rubber surround with Weather-Edge frame protection, high-temp fiberglass voice coil former, high temp voice coil wire, optimized cone geometry, linear temp voice coil wire, optimized cone geometry, linear. High Frequency: 19 mm (0.75 in) PEI diaphragm, low-viscosity ferro magnetic fluid, and lightweight Kapton™ voice coil former.

Physical; Enclosure Material: High Impact Polystyrene (HIPS), painted with highly-UV resistant paint on white (-WH) version for maximum UV fade resistance. Grille: Highly zinc-plated, finished in durable TGIC polyester powder coating. MTC-25WMG-1 (&-WH) available with Weather-Max™ multi-layer foam and tight-weave mesh vapor barrier backing. Installation: InvisiBall wall-mounting system included. Two 6 mm attachment points (on top and bottom) for optional MTC-25UB-1 (&-WH) U-bracket. Secondary safety attachment loop point on back panel. Termination: Screw-down terminal strip, zinc-plated copper based, nickel-plated metal screws and washers. Accepts up to 9 mm outside 4 mm inside open lugs (#6, #8, or #10 lug), plus bare wire (up to 12 AWG / 2.5 mm²). Optional MTC-PC2 and MTC-PC3 protective panel covers available to provide sealed entrance for additional weather protection.

5. Media Player with Bluetooth Receiver and AM/FM Tuner: Provide Denon Pro DN-300Z or equal. The media player shall feature:
- a. Super-fast loading, slot-in CD mechanism
 - b. Supports removable USB thumb and HDDs, SD/SDHC cards
 - c. Wireless audio playback from devices via Bluetooth
 - d. Plays CD, MP3, WAV, and AAC files
 - e. 3.5mm Aux-in for audio playback of other devices
 - f. AM/FM Tuner w/ dedicated audio out for multi-room use
 - g. Unbalanced combi audio output
 - h. 10-key direct track access
 - i. Random, Repeat One, Repeat All, and continuous play modes
 - j. Folder only and All play modes
 - k. IR controllable with included, compact remote
 - l. 1RU chassis with removable rack ears
 - m. Detachable IEC-weighted AC inlet
 - n. 100-220v switching power supply

Number of channels: 2 (stereo), 1 (mono), Audio frequency characteristics: 10Hz – 20kHz (+ 1.0 dB), S/N ratio: More than 95 dB (A-Weighted), Total harmonic distortion: Less than 0.01%, Dynamic range: More than 85 dB, Channel separation:

More than 80 dB, Bluetooth: Version 3.0, Output class: Class 2, Support Codec: SBC, MP3, AAC, aptX, Support Profile: A2DP, AVDTP 1.0, AVCTP 1.3, AVRCP 1.0, SSP.

Tuner Section: FM AM, Receiving range; North and South America: FM- 87.50 MHz–107.90, AM- 520 kHz – 1710 kHz, Sensitivity: 30 dB μ V / m 60 dB μ V / m, Channel separation: 20 dB (0 kHz), S/N ratio: FM- More than 40 dB, AM- More than 30 dB, THD+N (1 kHz) Monoaural 3.0%, Stereo 3.0%.

Output Section: Analog Out L/R- Type: RCA terminal, Load impedance: Over 10 k Ω /kohms, Output level: 2 Vrms / at 10 k Ω /kohms load.

Input Section: AUX-in: Type: TRS terminal (\varnothing 3.5), Input impedance: Over 10k Ω /kohms, Maximum input level: 1 Vrms, Maximum output level: 3 Vrms

6. Microphones and cables:

- a. Provide Shure ULXD4D digital wireless microphone or equal. The digital wireless system shall operate in the VHF, UHF, ISM (900 MHz), 1.2 GHz, 1.5 GHz, or 1.8 GHz band with the specific range being dependent on the user's locale. The system shall include the option of changing the operating frequency in order to avoid RF interference. Preconfigured group, channel and frequency setups shall be available to ensure that multiple systems in use do not interfere with one another.

The transmitter front end shall optimize itself for standard inputs without requiring transmitter gain adjustments thus allowing all gain changes to be made at the receiver, which shall provide a 60 dB range of system gain. Overall system signal to noise ratio shall be >120 dB. The system shall offer a choice of single-channel, dual-channel, and quad-channel rackmount receivers. Dual- and quad-channel receivers shall include DanteTM digital audio networking in addition to analog audio outputs. All receivers shall include DC power on the RF inputs for use with directional antennas and antenna distribution components.

The receiver shall include an RF level meter, an audio level meter, and a Networking Interface Connector for computer control and monitoring. The system shall detect RF interference and indicate such to the user via the LCD and RF meters. The system shall use technology such as digital predictive diversity to optimize RF stability.

The system shall include always-on AES-256 encryption that cannot be disabled. The encryption scheme shall conform to the US Government National Institute of Standards and Technology (NIST) publication FIPS-197. The encryption mechanism shall utilize a randomized key that is not transmitted via RF.

Provide compatible antenna system for remote mounting and extension of the antenna.

- c. The following microphones, cables, and stands shall be provided for various assembly purposes:
 - i. Provide (4) Shure SM58-CN cardioid, dynamic microphones.
 - ii. Four XLR male to XLR female shielded microphone cables, (25) feet in length.
 - iii. Four Ultimate MC-77B stands or equal. Stands shall feature one-handed height adjustment, weighted and stackable bases, telescoping height of 39" to 64", weight shall be eight lbs and finished in black.
- 7. Assistive Listening System: Provide Williams Sound FM+ system package #FM 558-12 or equal. The system shall consist of an FM transmitter, (12) R38 receivers, (12) Surround earphones, (3) neckloops (1) ADA wall plate. The transmitter shall feature: User Interface: 3.12" High Resolution OLED display with selections via buttons. Hosted Web page. Remote control and monitoring. Ethernet: RJ-45 on back of unit supports CAT 5e cable lengths up to 328 feet (100 meters); 10/100 Base-T IEEE 802.3 compliant, unique MAC address, RF Section: Operating Frequencies 72.1-75.9 MHz , 17 wideband channels (selectable), Frequency Accuracy ± 2 ppm stability, 0-50° C, Deviation ± 75 kHz maximum, Pre-Emphasis 75 microsec, RF Field Strength Does not exceed 80 mV/m at 3 m, Compatible Antennas ANT 005, ANT 021, ANT 024, ANT 025, ANT 029.

Transmission Range Up to 1000 ft (304 m) with ANT 005 coaxial antenna mounted on rear chassis connector. RF Outputs (1x) #10-32 stud connector in center of unit (pcb mounted) (1x) F-connector on rear chassis, RF Transmit Indicator 1 Green LED On Air Indicator RF Power Full, Medium, Low or OFF indicated by menu icon. RF Time Out (sleep mode) 30 min. duration, 4 hr. duration, or Always On selected via menu. Starts when audio is below -18 dB level with no button pressed for selected duration.

Audio Section: Audio Processor Functions DSP based; Compression: 1:1, 1.5:1 or 2:1; High-pass and Low-pass Filter Frequency control, Frequency Response 31-16000 Hz, ± 3 dB (re: 1 kHz, ± 3 dB) ("Music" Audio Preset) Signal-to-Noise Ratio 67 dB (typical) Transmitted RF Total Harmonic Distortion Less than 0.25% @ 1 kHz (RF output) Common Mode Rejection Greater than 57 dB @ 1 kHz, Mic or Line.

Audio Inputs (1x) Combination 3-pin XLR, 1/4" (TRS) jack for balanced or unbalanced line level, or balanced or unbalanced microphone with selectable phantom power Audio Input Gain Adjust In menu, adjustable to 0 to -50 dB, in 1dB steps.

Phantom Power 14.4 VDC applied through 2.2 kOhms resistors to analog combo jack: Pin 2 and Pin 3 on XLR jack, or tip and ring on 1/4" TRS jack.

Audio Level Indicators: 10-LED array that reads -18 to +9 dB at 3 dB intervals. 7 Green, 2 Amber, and 1 red LED. Green LEDs indicate normal operating audio level

peaks, Amber LEDS indicate close to overload peaks, Red LED indicates overload peaks.

Headphone Output: 1/4" TRS stereo jack, mono signal, 14.85 mW at +9dB, maximum in 33 Ω (level adjustable in menu 0 to -40 dB in 2 dB steps). Line Output RCA jack (black), -10 dBV (.32 VRMS); Output impedance 100 ohms at +9dB.

Input Levels (Bal or Unbal) (at Audio Input Gain = 0dB) Nominal (1st Amber + 3dB LED) Overload Warning (Displayed on Screen) Absolute Max. Rating.

Microphone -55 dBV (1.7 mV RMS) -22 dBV (80 mV RMS) +20 dBV (10.0 V RMS), Line -25 dBV (55 mV RMS) +16 dBV (6.3 V RMS) +20 dBV (10.0 V RMS) 70° C

Warranty: 2-year parts and labor. Dimensions 8.45" W x 8.25" D x 1.72"H (21.5 cm x 21 cm x 4.4 cm)

8. Rack Enclosures:

- a. Free standing, floor mounted audio racks manufactured by Chief, Atlas, Middle Atlantic or equal will be accepted. Included shall be a lockable rear door and a lockable perforated front door.
- b. Provide all necessary mounting hardware for equipment and wiring.
- c. Audio rack quantities & sizes shall be determined by the rack mounted equipment that will be installed. Contractor shall arrange the equipment for proper air flow and accessibility to the equipment mounted in the rack. Provide necessary vented blank panels between equipment. Contractor shall submit a rack elevation with all the equipment, spaces and vents required for approval as part of the shop drawing submittals
- d. Provide (1) portable, lightweight audio rack for installation of the Shure wireless microphones for production use in the cafeteria/stage.

9. Rack Power:

- a. Provide Juice Goose JG8.0L power distribution center or equal.
- b. Provide SurgeX Sx1120RT power conditioner featuring:
 - 1) Magnetic shielding steel enclosure
 - 2) 8 grounded AC receptacles on rear panel, 6 switched, 2 always on.
 - 3) Front panel courtesy receptacle.
 - 4) Advanced Series Mode surge protection.
 - 5) Advanced Impedance Tolerant EMI/RFI filtering.
 - 6) SurgeX ICE inrush current elimination technology.
 - 7) COUVES catastrophic over/under voltage shutdown.
 - 8) Remote turn on.
 - 9) Thermal circuit breaker overload protection.
 - 10) 10 year warranty.
- c. Provide Lyntec NPAC network power automation control or equal.
- d. Surgex UPS-1000-Li-2 surge protection for each rack.

10. Provide stainless steel microphone / line input plates for connection of microphones and line level equipment. Quantity, location, and type of plates are listed on the drawings. The microphone / line input plates shall be terminated and properly marked to the audio rack. All plates shall be engraved as described on the drawings. Silk screen identification will not be accepted. Face plate color shall be stainless steel with black engraved letters.
11. AV Patch panels: Provide PoE++ managed switches. Switches manufactured by Netgear, Cisco, Trendnet, and similar manufacturers will be accepted. Provide the number of ports required for the system designed (regardless of the port quantity noted on the dwgs) with a minimum of (4) additional open ports for future use.

2.2 CONTRACTOR'S DOCUMENTATION:

- A. As-Built Drawings. Provide three (3) sets. The Contractor shall provide complete point to point wiring schematics of all system components including audio, video and control. Drawings shall include cable numbering, equipment locations, jacks, input /output plates etc.
- B. A final set of as-built drawings shall be provided within 10 working days of acceptance by the Owner. Two copies of this as-built information shall be provided one to the Owner and one to the Engineer. As-builts shall be provided on reproducible media, and one CD Rom.
- B. The Contractor is to keep on file a complete set of as-built drawings to be used for future service actions and future system enhancements.
- D. Any and all custom furniture, carts, consoles etc. shall be documented in CAD form and provided with the as-builts.
- E. Any and all wall plates, auxiliary panels etc. are to be provided as a part of the as-builts.
- F. Manufacturer Documents - Provide three (3) sets. All equipment item manufacturer manuals shall be provided as a part of the contractors documentation package. All manuals are to be inserted into 3 ring binders. Also included in these binders are to be a complete equipment list of the serial numbers and manufacturer warranty information

2.3 COOPERATION WITH OTHER TRADES:

- A. It shall be the responsibility of the Contractor to cooperate at all times, and to the fullest extent, with all trades doing work in the building.
- B. The Contractor shall be responsible to meet anticipated project schedules regardless of any and all local disputes.

2.4 INSTALLATION STANDARDS:

- A. Qualified technicians shall perform all equipment, cabling and materials installation in a professional manner, in accordance with industry standards.
- B. All equipment (permanent and portable) will be mechanically mounted as needed to prevent any unwanted movement (instability, vibration) during normal usage.
- C. All mounting hardware and/or brackets shall be concealed wherever possible. The same type of hardware shall be used on all wall plates.
- D. All equipment will be mounted with symmetry and center of gravity in mind.
- E. All cabling on portable equipment will be dressed neatly and orderly with care taken that no cabling can be "snagged" when it is being moved.
- F. All audio and control cabling will be installed within the NEC installation parameters for application and routing.
- G. All cabling will be installed in a neat and orderly fashion.
- H. Cabling:
 - 1. All audio and control cabling will be installed within the NEC installation parameters for application and routing.
 - 2. All cabling will be installed in a neat and orderly fashion.
 - 3. Cabling will be secured and strain-relieved at all appropriate locations.
 - 4. All cable connections to equipment will have maximum accessibility and cable labels will be visible.
 - 5. Any piece of equipment will be removable without cutting wire ties or cable harnesses.
 - 6. Service loops will be provided where necessary.
 - 7. All cables run through plenum environments will be Teflon-jacketed in accordance with local fire codes.
 - 8. Cables will not be gouged, bent, or otherwise damaged during installation or termination. Cables will not rest against any sharp metal edges. Grommets, plastic collars, or rubberized tape will be used where appropriate.
 - 9. Cables and bundles will be dressed to look neat, orderly, and with the idea that a technician, who may be unfamiliar with the system, can find his or her way around the system with the aid of the documentation.
- I. Equipment Rack Cabling Practices:
 - 1. Internal equipment rack cabling shall conform to professional installation standards. All cables should be securely mounted within the rack to allow easy removal of the connector and visibility of the cable label. All cables shall be run to

approach its connection point at the perpendicular, with a minimum length of 4" between the connector itself and the cable secured mounting. Cabling and connections shall include sufficient strain relief and lack of stress to eliminate potential intermittent break in proper signaling.

2. AC electric power strips shall be mounted on the left side of the equipment rack. All equipment power shall be derived from this central power location and not intermingled with signal or control cabling. High Voltage surge protection will be included where necessary to protect sensitive electronic equipment from harmful voltage spike.
 3. Audio cabling shall be grouped in accordance to the signal level present in the specific wiring, paying careful attention to the separation of microphone level, line level and amplified signal levels.
- J. Connection Plates:
1. All connection plates will be aluminum or stainless steel stock unless otherwise requested by owner.
 2. All connectors will be isolated from AC power.
- K. Cable Labeling:
1. All cables will be labeled the same at both ends.
 2. Cable label designations will be clearly marked on schematic and block diagrams.
 3. Labels shall be located 3 to 9 inches from connector.
 4. Labels will be of 3M ScotchCode, Brady TM (or equivalent).
- L. Wallplates:
1. Wallplates will be fabricated to match the architectural finishes.
 2. Wallplates will be engraved with permanent lettering and numbering.
 3. Final layout lettering will be approved by the Owner or their representative prior to fabrication.
- M. Clean-up:
1. The Contractor will perform a general clean-up at the close of every work session. This will include clean-up of debris generated by the Contractor's technicians to the appropriate refuse containers on the particular floor on which they are working.
 2. The Contractor will, at all times, keep hazards to minimum. Items to be left on site (if any) will be stored in an orderly and "out-of-the-way" manner and are not the responsibility of the Owner. The exception to this would be for items left in Owner approved locked storage areas.

2.5 OWNER TRAINING:

- A. Training shall be provided to the owner for all installed systems. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system.
 - 1. Each training session shall be a minimum of two hours.
 - 2. Training shall consist of detailed operating functions and overall explanations of each systems capabilities and functionality.
 - 3. A user's manual shall be used as a guide for training.
 - 4. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of one hour.
 - 5. Contractor shall be present for the first event during operation.
 - 6. **All training sessions shall be video-taped. The tape shall be turned over to the Owner for future reference.**

2.6 WARRANTY:

- A. All manufacturer warranties are to apply for all equipment provided in this contract. For a minimum, all equipment items shall carry a manufacturer warranty that is supported by the installing contractor for a period of one year from the date of acceptance by the owner.
- B. Manufacturer warranties that provide more than one-year coverage shall also apply.
- C. If the contractor is not an authorized dealer for equipment provided, it is the sole responsibility of that contractor to bear all costs of providing warranty services for those equipment items. During the first year of system operation the owner shall bear no costs for any warranty repairs, and the contractor shall provide 24-hour service response for the first year. Any contractor modified equipment items that may render the original manufacturer's warranty void shall be warranted 100% by the installing contractor for a period of one year.

2.7 PERFORMANCE TESTING:

- A. The following details the minimum acceptable systems performance test procedures and results for audio and video systems performance.
 - 1. Test Equipment Required:
 - a. Variable Sine Wave Generator
 - b. Sound Pressure Level Meter
 - c. Distortion Analyzer
 - d. Calibrated Microphone
 - e. Real Time Spectrum Analyzer
 - f. AC/DC Voltage/Ohm Meter
 - g. Impedance Meter
 - h. TEF Analyzer
 - 2. Performance Standards: Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise mandated by the system

applications, the following shall be the minimum performance specifications of the system.

- a. Signal/ Noise Ratio, 55 dB minimum, (including crosstalk and hum)
- b. Total Harmonic Distortion, 1% maximum from 40 Hz to 15,000 Hz.
- c. Frequency Response, 40 Hz to 15,000 Hz +/- 2 dB, (Program Playback)

- 3. Application of Performance Specification: The minimum performance specifications cited above shall apply equally to individual equipment components and to all inter-component connections, including but not limited to: distribution amplifiers, switchers, signal routers, patch bays. All point to point interconnections between sources and outputs shall meet the aforementioned system specifications.

END OF SECTION 27 4000

SECTION 27 6100 – INSTRUMENTAL MUSIC SOUND SYSTEMS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The Electrical Contractor, as part of this section, shall provide, install and test a complete sound reinforcement system as specified herein for areas indicated on the drawings.
- B. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the sound reinforcement system.

1.2 SUBMITTALS

- A. Submit the following in accordance with Conditions of Contracts and Division 1 specifications sections:
 - 1. Audio functional
 - 2. Rack elevations
 - 3. Loudspeaker mounting details
 - 4. Conduit riser
 - 5. AV plate details
 - 6. Cable pull schedule
 - 7. Manufacturer equipment specification sheets

1.3 QUALIFICATIONS OF BIDDERS

- A. The bidder shall be a firm with a minimum of 5 years of experience in the fabrication, assembly, and installation of audio systems of similar magnitude and quality as specified in these documents, and shall submit documentation to this effect with the bid return.
- B. The bidder shall be I.C.I.A / A.V.S.P certified.

1.4 ALTERNATE EQUIPMENT

- A. This equipment was selected to establish a standard of quality and performance. The contractor may offer substitutes for approval but the burden of proof of equality shall be with the contractor.
- B. Pre-approval submittals shall contain a component-by-component comparison of all specification lines. Differences shall be clearly high-lited with the explanation and support

data. Connection drawings shall also be provided to establish how the substituted components will achieve the specified system design

- C. The contractor shall provide any additional documentation, samples, or performance tests required by the Engineer in order to establish proof of equality with the specified equipment.
- D. All substitutions shall provide equal or greater system performance and function. No substitute equipment shall be purchased or installed without approval by the Engineer.
- E. Final approval of the substituted equipment shall be given after the system has been installed. Failure to meet the specification, as determined by the Engineer, shall result in the removal of the substituted equipment and the installation of the specified equipment without any additional cost to the owner.
- F. When a piece of specified equipment has been discontinued by the manufacturer or is unavailable due to lack of inventory, the contractor may substitute the manufacturer's recommended replacement without notice to the Engineer. If a piece of equipment is not replaced by a newer model with the same or better features and a different manufacturer can supply a piece of equipment that meets or exceeds the original equipment, the contractor shall notify the Engineer and submit the equipment cut sheets for approval.

1.5 EXCEPTIONS

- A. Any and all exceptions to these specifications and related drawings must be made with the submission of the bid. In the absence of exceptions, the specifications and related drawings shall be binding in letter and intent on the successful bidder. It will also be understood that the bidder has examined the design and specifications in detail, and is prepared to take full responsibility for the performance of the complete installation as designed and specified.

1.6 SUB-CONTRACT INFORMATION

- A. Any and all sub-contractors that a bidder plans to utilize for this project are to be listed with the references and qualifications in the bid submission. The successful bidder shall supervise all sub-contract work. Any and all sub-contract work is the complete and sole responsibility of the contractor.

1.7 SPECIFICATION INFORMATION REQUESTS AND QUESTIONS

- A. Any requests for clarification shall be submitted to Mr. DJ Seibert of Snyder Hoffman Associates, 1005 West Lehigh Street, Bethlehem, PA, 18018, 610-694-8020, dseibert@snyderhoffman.com. All requests are to be made in writing and submitted no later than ten days prior to bid submission.

1.8 CERTIFICATIONS AND REPRESENTATIONS

- A. Quality of materials: All equipment items and installation materials will be new. No previously owned, demonstrated or otherwise used items will be provided. Note that prior to equipment installation and on-site integration, all equipment items shall be performance tested and quality checked to insure full functionality of each equipment item.
- B. Tax Statement Certification: The contractor certifies that all local, state, and federal taxes are separately listed in any price quotations.

1.9 QUALITY ASSURANCE

- A. All equipment and materials provided for this contract are to be new and shall meet or exceed the latest published specification of the manufacturer for that item.
- B. All equipment shall be UL listed or equivalent.

1.10 NOT IN CONTRACT

- A. Some equipment related to the audio system will be provided under the Electrical Contract. Unless otherwise indicated in these specifications or related drawings, these will include the following:
 - 1. All electrical breaker / load panels.

PART 2 PRODUCTS

2.1 EQUIPMENT DESCRIPTION

- A. System Electronics - Provide (1) of each piece of equipment for Instrumental Music 424 & Music 425 classrooms:
 - 1. The Instrumental & Music classrooms shall be provided with a complete locally controllable audio system. All equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electronically whether or not those specifications are delineated herein. The manufacturer's latest published specifications shall be considered as part of this text. Quantities shown on the contract drawings.
 - 2. Mixer / Amplifier: Provide Ashly mXa-1502 or equal. The unit shall consist of a two-channel, multi-mode Class D amplifier capable of driving 2 Ohm

loads at full power. Each channel shall have selectable output mode of Low Z, 25V, 70V, or 100V with a maximum rated output power of 150W per channel in all modes and will be bridgeable to deliver a single channel power output of 300W @4 or 8 Ohms. There shall be an automatic but defeatable sleep mode consuming <1W. A switch-mode power supply with active Power Factor Correction (PFC) shall auto-detect 100 – 240VAC mains and operate from 70 – 270VAC.

The unit shall have a multi-channel, user-programmable DSP capable of mixing 8-mic/line inputs, plus 4 stereo line inputs into 4 independent outputs. The mic inputs shall each provide 48V phantom power, switchable per channel via software. Each Input DSP channel shall have up to six assignable DSP function blocks, which shall be arrangeable in any order by the user and which may include: Gain, VCA Gain, DCA Gain, Remote Gain, 10-band PEQ, 31-band graphic EQ, HPF, LPF, Compressor, Auto-Leveler, Brick Wall Limiter, Gate, Feedback Suppressor, Delay, Signal Generator & Meter. DSP functions for the stereo channels shall also be stereo. Each Input shall allow routing to up to four mixers, each of which provides: Gain, Meter, Auto-Mix & Ducker assignable to each input channel. The unit's Output DSP consists of four channels, each having six assignable blocks, also arrangeable in an order by the user and which may include: Gain, VCA Gain, DCA Gain, Remote Gain, 10-band PEQ, 31-band graphic EQ, HPF, LPF, Compressor, Auto-Leveler, Brick Wall Limiter, Gate, Ambient Noise Compensation, FIR Filters, Delay, X-Over (2, 3 & 4-way), Signal Generator & Meter. Each Output Channel shall allow receiving a signal from any one of the four mixers as determined by the user. The four Output Channels shall feed the two amplifier channels (AMP OUT 1 & AMP OUT 2) and the two AUX Line Out Channels (AUX OUT 1 & AUX OUT 2) respectively in a fixed configuration.

The unit's DSP shall also incorporate an RTC (Real-Time Clock), which can be synchronized to an external clock source (such as a PC or NTP server). The unit shall have a built-in scheduler (driven by the RTC), which can be programmed by the user for various timed operations, such as: power-on/standby, preset recall, sub-preset recall, source select, channel mute/unmute & channel gain adjustment (\pm). The unit's DSP shall be managed by an internal web-server and database and controlled by a networked PC or tablet device which is browser-enabled. It shall therefore not be required that a separate software application be installed on a PC or other device, in order for the user to access DSP functions.

Mechanical: The front panel shall have LEDs indicating Input Signal (green), Clip/Mute (Red), Current (Green) and Temperature (Yellow) for each power channel and will also have global LEDs for indicating the amp's Protect (Red), COM (Green), Disable (Yellow) and Sleep (Blue) modes. The front panel shall have four momentary buttons that may be user-programmed to perform preset recall or source-select functions. There shall also be a round momentary Power

button with a white LED backlight to indicate the amp's "ON" status. The front grille shall be composed of high-impact resin and shall be perforated to allow proper airflow.

The unit's rear panel shall have 8-Balanced Mic/Line inputs each with removeable 3.5mm Euroblock connectors and will also have 4-stereo unbalanced Line Inputs, each with dual RCA phono connectors. The unit will have two balanced line (AUX) outputs with removeable 3.5mm Euroblock connectors and two powered speaker outputs, which shall have 7.62mm Euroblock connectors. The unit shall have 8-addressable GPI & 2-GPO, 2-Amplifier Fault, 3-VC Remote, 1-Serial Data and 1-Amplifier Standby ports, all with removeable 3.5mm Euroblock connectors. There shall be a DIP-switch pair for each power amp allowing selection of amplifier mode (Low Z/25/70/100V). The unit shall be networkable and shall have an RJ45 100/1000BaseT Ethernet jack. The unit shall have a detachable IEC power receptacle capable of working with region appropriate power cables.

The unit shall be housed in a 1U metal chassis, with front and side perforations to allow proper cooling from the variable-speed fan. The unit shall weigh <11.3 lbs. (5.1kg) and shall measure 19" W x 1.75"H x 14.54" D (483mm x 45mm x 369mm) and mount in a standard 19" rack. There shall be a five-year warranty for units purchased in the US.

3. Media Player with Bluetooth Receiver and AM/FM Tuner: Provide Denon Pro DN-300Z or equal. The media player shall feature:
 1. Super-fast loading, slot-in CD mechanism
 2. Supports removable USB thumb and HDDs, SD/SDHC cards
 3. Wireless audio playback from devices via Bluetooth
 4. Plays CD, MP3, WAV, and AAC files
 5. 3.5mm Aux-in for audio playback of other devices
 6. AM/FM Tuner w/ dedicated audio out for multi-room use
 7. Unbalanced combi audio output
 8. 10-key direct track access
 9. Random, Repeat One, Repeat All, and continuous play modes
 10. Folder only and All play modes
 11. IR controllable with included, compact remote
 12. 1RU chassis with removable rack ears
 13. Detachable IEC-weighted AC inlet
 14. 100-220v switching power supply

Number of channels: 2 (stereo), 1 (mono), Audio frequency characteristics: 10Hz – 20kHz (+ 1.0 dB), S/N ratio: More than 95 dB (A-Weighted), Total harmonic distortion: Less than 0.01%, Dynamic range: More than 85 dB, Channel separation: More than 80 dB.

Bluetooth: Version 3.0, Output class: Class 2, Support Codec: SBC, MP3, AAC, aptX, Support Profile: A2DP, AVDTP 1.0, AVCTP 1.3, AVRCP 1.0, SSP.

Tuner Section: FM AM, Receiving range; North and South America: FM- 87.50 MHz–107.90, AM- 520 kHz – 1710 kHz, Sensitivity: 30 dB μ V / m 60 dB μ V / m, Channel separation: 20 dB (0 kHz), S/N ratio: FM- More than 40 dB, AM- More than 30 dB, THD+N (1 kHz) Monoaural 3.0%, Stereo 3.0%.

Output Section: Analog Out L/R- Type: RCA terminal, Load impedance: Over 10 k Ω /kohms, Output level: 2 Vrms / at 10 k Ω /kohms load.

Input Section: AUX-in: Type: TRS terminal (\varnothing 3.5), Input impedance: Over 10k Ω /kohms, Maximum input level: 1 Vrms, Maximum output level: 3 Vrms

4. Microphones and cables: The following microphones, cables, and stands shall be provided for various assembly purposes:
 - a. Provide (4) Shure SM58-CN cardioid, dynamic microphones. (2 for each room)
 - b. Provide (4) Shure SM57 Dynamic instrument microphones. (2 for each room)
 - c. (6) XLR male to XLR female shielded microphone cables, (25) feet in length. (2 for each room)
 - d. (4) Ultimate MC-77B stands or equal. Stands shall feature one-handed height adjustment, weighted and stackable bases, telescoping height of 39" to 64", weight shall be eight lbs and finished in black. (2 for each room)
5. Studio Live AR8c. Provide Presonus StudioLive AR8c, 8-channel analog mixer or equal. The audio mixer shall feature the following: Microphone Preamp: Type; XLR Female, Class A XMAX, Maximum Input level (unity gain) +9 dBu +/- 1.0 dB, Gain Control Range 43 dB (+12 to +55 dB), Frequency Response to Analog Outputs 20 Hz to 20 kHz, +0.5/-1.5 dB, Frequency Response to USB (Direct) 20 Hz to 20 kHz, +0.5/- 1.5 dB, S/N Ratio to Outputs (+4 dBu) 94 dB, THD+N (min. gain, A-wtd) < 0.01%, Input Impedance 1 k Ω , EIN (+55 dB gain, 150 Ω input, 20 Hz-22 kHz, A-wtd) < -128 dBu, Common Mode Rejection Ratio (1 kHz, +55 dB gain) 65 dB, Phantom Power +48 V, \pm 3V, Global.

Instrument Inputs: Type; 1/4" TS Female, Unbalanced, Hi-Z, Maximum Input Level (min. gain, 1 kHz@0.5% THD+N) +9 dBu \pm 1.0 dB, Gain Control Range 43 dB (+12 to +55 dB), Frequency Response to Analog Outputs 20 Hz to 20 kHz, +0.5/-1.5 dB, Frequency Response to USB (Direct) 20 Hz to 20 kHz, +0.5/-1.5 dB, Dynamic Range (min. gain, A-wtd) > 105 dB, Dynamic Range (mid. Gain, unwtd) > 108 dB, THD+N (1 kHz, -1 dBFS, A-wtd) < 0.01%, THD+N (1 kHz, -1 dBFS, unwtd) < 0.01%, Input Impedance > 1 M Ω .

Line Inputs: Type; 1/4" TRS Female, Balanced, Maximum Input Level (min. gain, 1 kHz@0.5% THD+N) +26 dBu +/- 1.0 dB, Gain Control Range Mono Channels: 40

dB +/- 1.0 dB (-5 to +35 dB) Stereo Channels: 0 dB or +10 dB (+10 dB Boost), Frequency Response to Analog Outputs 20 Hz to 20 kHz, +0.5/-1.5 dB, Frequency Response to USB (Direct) 20 Hz to 20 kHz, +0.5/-1.5 dB, S/N Ratio to Analog Outputs (+4 dBu) 85 dB, THD+N (1 kHz, -1 dBFS, A-wtd) < 0.01%, Input Impedance (Balanced) 10 kΩ.

Main, Control Room, Aux, and FX Outputs: Type; (Main Outputs) XLR Male, Impedance Balanced, Type: (Control Room, Monitor, FX Outputs) ¼" TRS Female, Balanced, Rated Output Level (Main Outputs) +24 dBu, ±1.0 dB, Rated Output Level (Control Room, Aux, FX Outputs) +18 dBu, Frequency Response 20 Hz to 20 kHz, +0.5/-1.5 dB, Dynamic Range (A-wtd) > 108 dB, THD+N (Bandwidth 20~20 kHz, -1 dBFS, unwt'd) < 0.01%, Output Impedance 100 Ω

Headphone Output: Type; ¼" TRS Female, Stereo, Unbalanced, Maximum Output Level 150 mW/channel @ 56Ω, Frequency Response 20 Hz to 20 kHz, +0.5/-1.5 dB, Dynamic Range (a-wtd) > 103 dB, THD+N (Bandwidth 20~20 kHz, -1 dBFS, unwt'd) < 0.01%

System Crosstalk: Input to Output (Ref = +4 dBu, 20 Hz to 20 kHz, unwt'd) -90 dBu, Adjacent Channels (Ref = +4 dBu, 20 Hz to 20 kHz, unwt'd) -85 dBu

Signal Level LED Signal -30 dBFS (pre-EQ), Clip -3.0 dB before clip (pre- or post-EQ)

Channel EQ: Low Cut 100 Hz, -18 dB/octave, High Shelving ±15 dB @ 10 kHz, Mid Peaking (Mono Channels: AR16c, AR12c) ±15 dB @ 140 Hz to 3.5 kHz (variable), Mid Peaking (Stereo Channels: AR16c, AR12c, All: AR8c) ±15 dB @ 2.5 kHz, Mid-Band Q Boost: 1.0, Cut: 2.5, Low Shelving ±15 dB @ 100 Hz.

Audio Interface: Host Interface USB 2.0, ADC Dynamic Range (Component) 114 dB, DAC Dynamic Range (Component) 114 dB, Signal to Noise (A-wtd) -96 dB, Bit Depth 24-bit, Internally Supported Sample Rates 44.1, 48, 88.2, 96 kHz, Jitter <80 ps RMS (20 Hz – 20 kHz), Jitter Attenuation >60 dB (1 ns in => 1 ps out)

SD Recorder: Supported Media Format FAT16-formatted SD Card, FAT32-formatted SDHC Card, Media Storage Capacity SD Card: 2 GB, SDHC Card: 32 GB, Recording File Format Stereo WAV, Playback File Formats Stereo WAV, MP3, Sampling Rate (WAV) 44.1 kHz, Bit Depth Recording: 24-bit, Playback: 16- and 24-bit

Physical: Power connector IEC, Input Voltage Range 90 to 240 VAC, Length 12.3", Width 11", Height 3.5", weight 7.1lbs

6. LOUDSPEAKERS

- a. ***Provide Desono CM60DTD, two-way, 6.5" recessed ceiling loudspeaker or equal.*** The speaker shall feature; Operating Mode: Passive, Operating Environment: Indoor, Operating Range (-10dB): 75 Hz to 22 kHz, Nominal Beamwidth (H x V): 150° conical, Transducers: LF 1 x 6.5" (165 mm) coated paper cone - HF 1 x 1" (25 mm) soft dome, Continuous Power Handling @ Nominal Impedance: 31V 60W @ 16Ω (240W peak), Nominal Sensitivity @ 1m: @ 1W 86 dB - @ 2.83V 83 dB, Nominal Maximum SPL @ 1m: Peak 110 dB – Continuous 104 dB, Transformer: 70V: 60W, 30W, 15W, 7.5W, 3.75W - 100V: 60W, 30W, 15W, 7.5W, Protection: 3-step self-resetting protection.

Input Connection: (1) 4-way Euroblock connector with permanent pass-through, Mounting Provisions: 2 mounting clamps with grip range of 0.2" - 2.6" (3 - 65 mm); Cover plate with 0.75" (22 mm) NPT knockout for conduit connectors, Safety Features: 2 hang points, Compliance: ETL listed to comply with UL 1480A and UL 2043; Certified to CSA C22.2#62368-1; Suitable for use in air handling spaces per NFPA 70, NFPA 90, Dimensions H x Dia.: 6.2" x 10.2" (157 mm x 258 mm), Weight: 8.8 lbs (4.0 kg), Accessories: (included) Tile rails; tile rail spacers; cutout template

- b. ***Provide JBL EON610 active loudspeakers or equal.*** System Type: Self powered 10", two-way, bass-reflex Maximum SPL Output: 124 dB Frequency Range (-10 dB): 52 Hz -20 kHz Frequency Response (±3 dB): 60 Hz - 20 kHz EQ: 3 Parametric EQ's, High and Low Shelf (Available via Bluetooth app only)

Amplification Amplifier Design: High Efficiency Class D System Power Rating: 1000W Peak (700 LF + 300HF); 500W Continuous (350W LF + 150W HF) Input Impedance: 20K ohms (Balanced) Line Input Gain: Infinity to +26.8dB (+14dBu max input level) Mic Input Gain: Infinity to +29dB (in addition to line input gain) Connectors: 2 x Balanced XLR-1/4" combination inputs; 1 x male XLR loop thru out LED Indicators: Power, Bluetooth, EQ Preset, EQ +, Signal CH1, Signal CH2, Limit Cooling: Passively Cooled (No Fan) AC Power Input: 100-120VAC 50/60Hz; 230-240VAC 50/60Hz AC Power Consumption (120VAC): 1/8th Power – 1.14A (Max), 1/4th Power – 1.71A (Max), 1/3rd Power – 2.03A (Max)

Speaker Specification LF Driver: 1 x JBL 610H 322mm (10 in) woofer HF Driver: 1 x JBL 2414H-1 25.4mm (1 in) polymer diaphragm, neodymium compression driver Coverage Pattern: 110° H x 60° V nominal Crossover Frequency: 1.8 kHz

Enclosure Material: Polypropylene, multi-purpose main & monitor Suspension / Mounting: 36mm pole socket with stabilizing screw, 3 x M10 suspension points Handles: One left, one right, one top, one bottom (4 total) Finish: Black Granite Grille: Powder coated perforated steel with

acoustically transparent screen backing Dimensions (H x W x D): 558 mm x 322 mm x 295 mm (21.968" x 12.677" x 11.614") Gross Weight: 11.79 kg (26 lbs)

7. Rack Enclosure:

- a. Provide Lowell Tilt-out Wall Rack #LTCR-3320S or equal. The surface-mount wall rack with tilt-out operation shall feature: Dimensions - 34.06"H x 6.8"D x 25.00"W. Construction shall be steel with neutral Network Grey powder epoxy finish.

The rack shall feature two bays, top/bottom vents, and combination knockouts in top, bottom, and rear. The upper bay with hinged pocket door shall mount 19"W x 5.25"H (3U) x 4.3"D equipment horizontally and include 10-32 threaded rails that pivot down for access. The lower bay shall tilt down to open (dampers shall control the rate of descent). It shall mount 19"W x 5.25"H (3U) x 15.3"D equipment vertically and feature 10-32 threaded rack rails plus a removable shelf. The assembly shall have a load capacity of 50 lbs. and include a single gang E.O. box in the base. Options: The rack shall include a 3U x 19"W punched panel to mount one-gang devices, #D8P-ID-3.

- b. Provide all necessary mounting hardware for equipment and wiring.

8. Provide stainless steel microphone / line input plates for connection of microphones and line level equipment. Quantity, location, and type of plates are listed on the drawings. The microphone / line input plates shall be terminated and properly marked to the audio rack. All plates shall be engraved as described on the drawings. Silk screen identification will not be accepted. Face plate color shall be stainless steel with black engraved letters.

2.2 CONTRACTOR'S DOCUMENTATION:

- A. As-Built Drawings. Provide three (3) sets. The Contractor shall provide complete point to point wiring schematics of all system components including audio, video and control. Drawings shall include cable numbering, equipment locations, jacks, input /output plates etc.
- B. A final set of as-built drawings shall be provided within 10 working days of acceptance by the Owner. Two copies of this as-built information shall be provided one to the Owner and one to the Engineer. As-builts shall be provided on reproducible media, and one CD Rom.
- C. The Contractor is to keep on file a complete set of as-built drawings to be used for future service actions and future system enhancements.

- D. Any and all custom furniture, carts, consoles etc. shall be documented in CAD form and provided with the as-builts.
- E. Any and all wall plates, auxiliary panels etc. are to be provided as a part of the as-builts.
- F. Manufacturer Documents - Provide three (3) sets. All equipment item manufacturer manuals shall be provided as a part of the contractors documentation package. All manuals are to be inserted into 3 ring binders. Also included in these binders are to be a complete equipment list of the serial numbers and manufacturer warranty information

2.3 COOPERATION WITH OTHER TRADES:

- A. It shall be the responsibility of the Contractor to cooperate at all times, and to the fullest extent, with all trades doing work in the building.
- B. The Contractor shall be responsible to meet anticipated project schedules regardless of any and all local disputes.

2.4 INSTALLATION STANDARDS:

- A. Qualified technicians shall perform all equipment, cabling and materials installation in a professional manner, in accordance with industry standards.
- B. All equipment (permanent and portable) will be mechanically mounted as needed to prevent any unwanted movement (instability, vibration) during normal usage.
- C. All mounting hardware and/or brackets shall be concealed wherever possible. The same type of hardware shall be used on all wall plates.
- D. All equipment will be mounted with symmetry and center of gravity in mind.
- E. All cabling on portable equipment will be dressed neatly and orderly with care taken that no cabling can be "snagged" when it is being moved.
- F. All audio and control cabling will be installed within the NEC installation parameters for application and routing.
- G. All cabling will be installed in a neat and orderly fashion.
- H. Cabling:
 - 1. All audio and control cabling will be installed within the NEC installation parameters for application and routing.
 - 2. All cabling will be installed in a neat and orderly fashion.

3. Cabling will be secured and strain-relieved at all appropriate locations.
4. All cable connections to equipment will have maximum accessibility and cable labels will be visible.
5. Any piece of equipment will be removable without cutting wire ties or cable harnesses.
6. Service loops will be provided where necessary.
7. All cables run through plenum environments will be Teflon-jacketed in accordance with local fire codes.
8. Cables will not be gouged, bent, or otherwise damaged during installation or termination. Cables will not rest against any sharp metal edges. Grommets, plastic collars, or rubberized tape will be used where appropriate.
9. Cables and bundles will be dressed to look neat, orderly, and with the idea that a technician, who may be unfamiliar with the system, can find his or her way around the system with the aid of the documentation.

I. Equipment Rack Cabling Practices:

1. Internal equipment rack cabling shall conform to professional installation standards. All cables should be securely mounted within the rack to allow easy removal of the connector and visibility of the cable label. All cables shall be run to approach its connection point at the perpendicular, with a minimum length of 4" between the connector itself and the cable secured mounting. Cabling and connections shall include sufficient strain relief and lack of stress to eliminate potential intermittent break in proper signaling.
2. AC electric power strips shall be mounted on the left side of the equipment rack. All equipment power shall be derived from this central power location and not intermingled with signal or control cabling. High Voltage surge protection will be included where necessary to protect sensitive electronic equipment from harmful voltage spike.
3. Audio cabling shall be grouped in accordance to the signal level present in the specific wiring, paying careful attention to the separation of microphone level, line level and amplified signal levels.

J. Connection Plates:

1. All connection plates will be aluminum or stainless steel stock unless otherwise requested by owner.
2. All connectors will be isolated from AC power.

K. Cable Labeling:

1. All cables will be labeled the same at both ends.
2. Cable label designations will be clearly marked on schematic and block diagrams.
3. Labels shall be located 3 to 9 inches from connector.
4. Labels will be of 3M ScotchCode, Brady TM (or equivalent).

- L. Wallplates:
 - 1. Wallplates will be fabricated to match the architectural finishes.
 - 2. Wallplates will be engraved with permanent lettering and numbering.
 - 3. Final layout lettering will be approved by the Owner or their representative prior to fabrication.
- M. Clean-up:
 - 1. The Contractor will perform a general clean-up at the close of every work session. This will include clean-up of debris generated by the Contractor's technicians to the appropriate refuse containers on the particular floor on which they are working.
 - 2. The Contractor will, at all times, keep hazards to minimum. Items to be left on site (if any) will be stored in an orderly and "out-of-the-way" manner and are not the responsibility of the Owner. The exception to this would be for items left in Owner approved locked storage areas.

2.5 OWNER TRAINING:

- A. Training shall be provided to the owner for all installed systems. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system.
 - 1. Each training session shall be a minimum of two hours.
 - 2. Training shall consist of detailed operating functions and overall explanations of each systems capabilities and functionality.
 - 3. A user's manual shall be used as a guide for training.
 - 4. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of one hour.
 - 5. Contractor shall be present for the first event during operation.
 - 6. **All training sessions shall be video-taped.** The tape shall be turned over to the Owner for future reference.

2.6 WARRANTY:

- A. All manufacturer warranties are to apply for all equipment provided in this contract. For a minimum, all equipment items shall carry a manufacturer warranty that is supported by the installing contractor for a period of one year from the date of acceptance by the owner.
- B. Manufacturer warranties that provide more than one-year coverage shall also apply.
- C. If the contractor is not an authorized dealer for equipment provided, it is the sole responsibility of that contractor to bear all costs of providing warranty services for those equipment items. During the first year of system operation the owner shall bear no costs for any warranty repairs, and the contractor shall provide 24-hour service response for the first year. Any contractor modified equipment items that may render the original manufacturer's warranty void shall be warranted 100% by the installing contractor for a period of one year.

2.7 PERFORMANCE TESTING:

- A. The following details the minimum acceptable systems performance test procedures and results for audio and video systems performance.
1. Test Equipment Required:
 - a. Variable Sine Wave Generator
 - b. Sound Pressure Level Meter
 - c. Distortion Analyzer
 - d. Calibrated Microphone
 - e. Real Time Spectrum Analyzer
 - f. AC/DC Voltage/Ohm Meter
 - g. Impedance Meter
 - h. TEF Analyzer
 2. Performance Standards: Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise mandated by the system applications, the following shall be the minimum performance specifications of the system.
 - a. Signal/ Noise Ratio, 55 dB minimum, (including crosstalk and hum)
 - b. Total Harmonic Distortion, 1% maximum from 40 Hz to 15,000 Hz.
 - c. Frequency Response, 40 Hz to 15,000 Hz +/- 2 dB, (Program Playback)
 3. Application of Performance Specification: The minimum performance specifications cited above shall apply equally to individual equipment components and to all inter-component connections, including but not limited to: distribution amplifiers, switchers, signal routers, patch bays. All point to point interconnections between sources and outputs shall meet the aforementioned system specifications.

END OF SECTION 271100

SECTION 281300 - ACCESS CONTROL SYSTEM HARDWARE

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access Control Server Appliance.
- B. Related Sections:
 - 1. Section 28 01 00 - Operation and Maintenance of Electronic Safety and Security.
 - 2. Section 28 05 45 – Systems Integration and Unified Systems.
 - 3. Section 28 49 00 - Electronic Personal Protection Systems.
 - 4. Section 28 23 13 - Video Management System Interfaces.
 - 5. Section 28 49 00 - Electronic Personal Protection Systems.
 - 6. Section 28 51 15.11 - Information Interfaces to Access Control Systems.
 - 7. Section 28 51 15.13 - Information Interfaces to Video Surveillance Systems.
 - 8. Section 28 51 15.15 - Information Interfaces to Security Detection, Alarm, and Monitoring.
 - 9. Section 28 51 15.17 - Information Interfaces to Security Monitoring and Control.
 - 10. Section 28 51 15.19 - Information Interfaces to Mass Notification Systems.
 - 11. Section 28 51 15.21 - Information Interfaces to Life Safety Systems.
 - 12. Section 28 51 17 - Data Presentation.
 - 13. Section 28 51 19 - Control Room and Monitoring Equipment.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with Owner or Owner's representative regarding network configuration and estimated throughout utilization prior to performing network connections.
- B. Sequencing / Scheduling: Provide to Owner or Owner's representative a schedule and list of participants required to attend coordination and progress update meetings.
 - 1. Owner representative(s) for Facilities Management, Information Technology (IT) Services, and Security Management.
 - 2. General Contractor.
 - 3. Project Manager.
 - 4. Manufacturer's Representative.
 - 5. Project Architect.
 - 6. Project Engineer.
 - 7. Security Consultant.

1.3 INFORMATIONAL SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
 - 1. Substrate preparation instructions and recommendations
 - 2. Installation means and methods.
 - 3. Recommendations and requirements for proper storage and handling.
- C. Shop Drawings:
 - 1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
 - 2. Coordinate with locations listed on Contract Drawings.
- D. Warranty Information:
 - 1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.
- E. System Support Resources:
 - 1. Submit a list of available manufacturers providing fee based professional services available to the Contractor or Owner, including but not limited to the following:
 - a. Training.
 - b. Installation.
 - c. Commissioning.
 - d. Remote diagnostics and integration with 3rd party software and hardware systems.

1.4 CLOSEOUT SUBMITTALS

- A. Supply licensing and registration information for all software, hardware, firmware, operational, and administrative licenses.
- B. Supply network configuration backup files, restoration application and instructions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide products from manufacturer(s) with a minimum of 5 years in manufacturing access control and building automation products specified in this section.
- B. Installer Qualifications:
 - 1. Installer must be licensed to install video surveillance and security equipment as required by authority having jurisdiction.
 - 2. Installer must be certified in good standing by the manufacturer prior to bid date.

3. Installer must be capable of providing references that will attest to successful completion of projects of similar scope as the work noted in this section.

1.6 WARRANTY

- A. Manufacturer Warranty: Provide manufacturer's warranty covering parts and labor costs to repair or replace part that fail to perform.
 1. Warranty Period: Parts and labor warranty for 36 months from date of Substantial Completion or date of purchase, whichever comes first.
 2. Service During Warranty: Provide direct support to Owner via phone and email, including access to training and education in the form of documents, videos and other materials via the internet.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Motorola Solutions by The Tri-M Group, LLC.
 1. Contact Info: Jeremy Adams- JAdams@Tri-MGroup.com (610) 656-2701.
- B. Manufacturer List:
 1. Manufacturer: Motorola Solutions: Access Control Manager by The Tri-M Group, LLC.
- C. Substitution Limitations:
 1. No Substitutions Permitted.

2.2 ACCESS CONTROL SERVER APPLIANCE

- A. General: Provide access control server appliance as part of an expandable, role-based physical access control system with the following functionality:
 1. Software: Provide access control system software in accordance with section 28 13 00.
 2. Integrations: Provide system compatible with third party open field hardware.
 3. Interface: Provides access from web browser to allow full access to alarms, events, hardware and history from multiple devices, including mobile devices.
 4. Coordination: Integrates with a network video management system to coordinate video alarm events and physical access system.
 5. Administration: Provides remote access and administrator control, failsafe performance through cloud-based server architecture, and best practices backup, update, and upgrade performance.

2.3 ACCESS CONTROL SERVER ENTERPRISE APPLIANCE

- A. Basis of Design Product: Access Control Manager - Enterprise, by Motorola Solutions Installed by The Tri-M Group, LLC.
 - 1. Model: AC-APP-16R-ENT2-6; Access Control Enterprise Appliance with 16 readers.
 - 2. Add-on: AC-SW-LIC-16RCU-6-P; Access Control Manager 6, 16 Reader Count Software License. (Up to the supported maximum of 400 reader licenses.)
- B. System:
 - 1. Operating System: Secure embedded Linux OS.
 - 2. Storage: 1 TB SATA Hard Drive.
 - 3. Processor: Intel Xeon.
 - 4. Memory: No less than 8 GB DDR4 RAM.
 - 5. Network Interface: No less than Two Gigabit Ethernet RJ-45 port (1000Base-T).
 - 6. Integrated Remote Access Controller: Dell iDRAC 9 Enterprise.
- C. Mechanical:
 - 1. Form Factor: Standard 1U Rack mount chassis.
 - 2. Dimensions: 42.8 mm x 482.4 mm x 676.9 mm; (1.68" x 18.99" x 26.65").
 - 3. Weight: 8.77 kg (19.32 lbs).
- D. Power:
 - 1. Input: 90 to 264 VAC, 47-63 Hz.
 - 2. Power Supply: Single non-redundant.
 - 3. Power Consumption: 250 W.
- E. System Capacities:
 - 1. Card Readers: 16 to 400.
 - 2. Inputs: 5060.
 - 3. Outputs: 5060.
 - 4. Maximum Controller Count: 1024.
 - 5. Maximum Simultaneous Operators: 20.
 - 6. Maximum Identity Count: 250,000.
 - 7. Transactions (60 Minutes Sustained): 50,000.
 - 8. Maximum Stored Events: 150,000,000.
- F. Operating Range:
 - 1. Temperature: 10° C to 35° C (50° F to 95° F).
 - 2. Humidity: 10 - 80% Relative humidity (non-condensing).
 - 3. Vibration: 0.26Grms at 5–350Hz for 15 minutes.
 - 4. Shock: Six (6) pulses of 6 G for up to 11ms.
 - 5. Altitude: -15.2 m (-50 ft) to 3048 m (10,000 ft).

PART 3 EXECUTION

3.1 PREPARATION

- A. Configure and test access control system according to manufacturer's instructions.
- B. Test system configuration(s) in accordance with instructions provided by manufacturer.

3.2 INSTALLATION

- A. Install access control server appliance according to manufacturer's written instructions.
- B. Develop, install, and test software and databases for complete and proper operation of systems involved.
- C. Initialize system such that no additional programming is required, including setup of available software features.
- D. Review configurable features with Owner's Representative and establish a punch list for standard, device specific, location specific and access control specific configurations.
- E. Configure equipment requiring users to log on using a password with user/site-specific password/passwords. Retaining default passwords is not allowed.

3.3 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. Demonstrate administration and operation of devices described in this section.
 - 2. Demonstrate how to authorize users and applications to operate and configure installed devices.
 - 3. Demonstrate how an authorized user can gain access to and make changes to configuration.
 - 4. Demonstrate how to operate functionality configured for this project as defined by configuration punch list.
- B. License Assignment:
 - 1. Register software, hardware, firmware, operational or administrative licenses necessary for to operate or administer devices to Owner.
 - 2. Deliver to Owner's Representative proof of license registration from product manufacturer.

- C. System Adjustments:
 - 1. Program and configure devices in accordance with the established punch list such that no additional programming is required for operation by user.
 - 2. Modify configurations as necessary to adjust operating parameters and sequence of operations based on the Owner's operating requirements.
- D. Device Configuration Backup:
 - 1. Using access control system server backup functionality, perform a full system backup at the completion of the initial programming to a USB drive or customer local network shared folder (preferred option). Backup function could also be scheduled to execute system backup periodically.
 - 2. Deliver configuration backup files, restoration application and instructions detailing for restoration of back-up configuration.

END OF SECTION 281300

SECTION 281400 ACCESS CONTROL SYSTEM SOFTWARE AND DATABASE MANAGEMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access Control Software.
 - 2. Access Control Software Collaborations.
 - 3. Access Control Hardware Software Integrations.
 - 4. Access Control Software Interface.
 - 5. Access Control Software Administration.
 - 6. Accessory Software Schedule.
- B. Related Sections:
 - 1. Section 08 71 00 - Door Hardware
 - 2. Section 28 01 00 - Operation and Maintenance of Electronic Safety and Security.
 - 3. Section 28 05 45 – Systems Integration and Unified Systems.
 - 4. Section 28 49 00 - Electronic Personal Protection Systems.
 - 5. Section 28 23 13 - Video Management System Interfaces.
 - 6. Section 28 49 00 - Electronic Personal Protection Systems.
 - 7. Section 28 51 15.11 - Information Interfaces to Access Control Systems.
 - 8. Section 28 51 15.13 - Information Interfaces to Video Surveillance Systems.
 - 9. Section 28 51 15.15 - Information Interfaces to Security Detection, Alarm, and Monitoring.
 - 10. Section 28 51 15.17 - Information Interfaces to Security Monitoring and Control.
 - 11. Section 28 51 15.19 - Information Interfaces to Mass Notification Systems.
 - 12. Section 28 51 15.21 - Information Interfaces to Life Safety Systems.
 - 13. Section 28 51 17 - Data Presentation.
 - 14. Section 28 51 19 - Control Room and Monitoring Equipment.
- C. Definitions:
 - 1. Anti Passback (APB): A security measure that aims to prevent consecutive entries for one access card or prevent multiple people from using the same access card.
 - 2. Open Supervised Device Protocol (OSDP): An access control communications standard.
 - 3. Secure Copy Protocol (SCP): A means of securely transferring computer files between a local host and a remote host or between two remote hosts.
 - 4. Software Development Kit (SDK): A collection of software development tools in one installable package.
 - 5. Video Management System (VMS): A component of a security camera system that collects video from cameras and other sources, records and stores that video to a storage device, and provides an interface to both view the live video, and access recorded video.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with Owner or Owner's representative regarding network configuration and estimated bandwidth utilization prior to performing network connections.
- B. Sequencing / Scheduling: Provide to Owner or Owner's representative a schedule and list of participants required to attend coordination and progress update meetings.
 - 1. Owner representative(s) for Facilities Management, Information Technology (IT) Services, and Security Management.
 - 2. General Contractor.
 - 3. Project Manager.
 - 4. Manufacturer's Representative.
 - 5. Project Architect.
 - 6. Project Engineer.
 - 7. Security Consultant.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
 - 1. Substrate preparation instructions and recommendations
 - 2. Installation means and methods.
 - 3. Recommendations and requirements for proper storage and handling.
- B. Shop Drawings:
 - 1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
 - 2. Coordinate with locations listed on Contract Drawings.
- C. Warranty Information:
 - 1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.
- D. System Support Resources:
 - 1. Submit a list of available manufacturers providing fee based professional services available to the Contractor or Owner, including but not limited to the following:
 - a. Training.
 - b. Installation.
 - c. Commissioning.
 - d. Remote diagnostics and integration with 3rd party software and hardware systems.

1.4 CLOSEOUT SUBMITTALS

- A. Supply licensing and registration information for all software, hardware, firmware, operational, and administrative licenses.

- B. Supply network configuration backup files, restoration application and instructions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide products from manufacturer(s) with a minimum of 5 years in manufacturing access control and building automation products specified in this section.
- B. Supplier Certifications: Provide products from a supplier in compliance with the following:
 - 1. Department of Homeland Security Safety Act Certified.
 - 2. NISPOM Compliance (National Industrial Security Program Operating Manual).
 - 3. HSPD-12 and FIPS201-2 Certified.
 - 4. GSA Approved product list.
- C. Installer Qualifications:
 - 1. Installer must be licensed to install access control and security equipment as required by authority having jurisdiction.
 - 2. Installer must have certified staff on access control products prior to bid date.
 - 3. Installer must be in good standing by the manufacturer prior to bid date.
 - 4. Installer must be capable of providing references that will attest to successful completion of projects of similar scope as the work noted in this section.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Motorola Solutions By The Tri-M Group, LLC.
 - 1. Contact: Jeremy Adams- JAdams@Tri-MGroup.com (610) 656-2701.
- A. Manufacturer List:
 - 1. Motorola Solutions: Access Control Manager By The Tri-M Group, LLC.
- B. Substitution Limitations:
 - 1. No Substitutions Permitted.

2.2 ACCESS CONTROL SOFTWARE

- A. Basis of Design: Access Control Manager, by Motorola Solutions Installed by The Tri-M Group, LLC.
- B. Operating System: Secure embedded Linux OS.
- C. Access Control Software Capacities:
 - 1. Intelligent Controllers: 1024 per appliance allowing geographic independence from appliance via IP communication.

2. Access Control System Appliances Supported: Up to 100 linked appliances using replication.
3. Events Stored: Up to 150,000,000 per appliance.
4. Events Stored: Up to 75,000,000.
5. Sub-Panels: Up to 32 per intelligent controller.
6. Doors: Up to 64 per intelligent controller.
7. PIN Length: Between 2 and 8 digits.
8. Card Formats: Up to 128 per appliance.
9. Time Schedules: 255 per intelligent controller.
10. Holidays: 255 per intelligent controller.
11. Identity and Operator Database: Up to 500,000.
12. Client Connections: Up to 50.

2.3 ACCESS CONTROL SOFTWARE COLLABORATIONS

- A. Database Collaborations and Integrations: Provide access control software capable of integration with the following industry standard third-party databases.
 1. Bidirectional:
 - a. Lightweight Directory Access Protocol (LDAP/Active Directory).
 - b. Structured Query Language (SQL) Server.
 - c. Oracle Relational Database Management System (RDBMS).
 - d. Comma Separated Value (CSV).
 - e. REST API Integration.
 2. Push Only:
 - a. Extensible Markup Language (XML) for Event Push.
- B. Visitor Management Integration:
 - a. HID Global: Easy Lobby.
 - b. Splan.
 - c. Envoy
 - d. Savance.
- C. Custom Integrations
 1. Destination Dispatch
 2. Custom Integrations using RestAPI (as needed for project requirements)
- D. Video Integrations: Coordinate integration and unification requirements with 28 05 45.
 1. Avigilon Control Center.

2.4 ACCESS CONTROL HARDWARE INTEGRATIONS

- A. Panel Hardware:
 1. Mercury Security: Series 1, Series 2, and Series 3.
- B. Supported Reader Hardware:
 1. ~~Readers capable of OSDP and Wiegand data format.~~ **HID 40NKS-00-000000 card reader. (Addendum 05)**

2. ~~HID Global: All OSDP and Wiegand.~~

- C. Credential Technologies:
 - 1. Credentials capable of Open Card format (PROX, MiFare, DESFire CSN).
 - 2. HID Global: All Physical (SEOS, iClass, Prox, Mifare, DESFire) and Mobile (ORIGIO).
- D. Intrusion Detection Control Panels:
 - 1. Bosch B series: (B3512, B4512, B5512, B6512, B8512G, B9512G).
 - 2. Bosch D Series: (D9412GV4, D9412GV4 V2).
- E. Biometrics:
 - 1. Third party via Weigand or OSDP data format.
 - 2. ViRDI Biometrics: AC2000, AC5000.
- F. Wireless Locksets:
 - 1. Allegion; Schlage: Wireless locksets.
 - 2. ASSA ABLOY: Aperio line of devices.
 - a. Gen 5 AH20 and AH40 Hubs
 - 1) Requires Mercury LP1501, LP1502, and LP2500.
 - 3. ASSA ABLOY: Wi-Fi & POE via integration to DSR.
 - a. Sargent.
 - b. Passport 1000 P1.
 - c. Passport 1000 P2.
 - d. Profile Series v.S1.
 - e. Profile Series v.S2.
 - f. IN120.
 - g. IN220.
 - h. Corbin Russwin.
 - i. Access 700 PIP1.
 - j. Access 700 PWI1.
 - k. Access 800 IP1.
 - l. Access 800 WI1.
 - m. IN120.
 - n. IN220.
 - 4. Salto Systems: Locks via SALTO SHIP integration to Pro Access Space.
 - 5. SimonsVoss: SmartIntego Series.
 - 6. Schlage: LEB locks.
 - a. Includes RS-485 gateway mode.
 - 7. Schlage: NDEB locks.
- G. Includes RS-485 gateway mode. Crash Bars:
 - 1. Von Duprin. RU & RM
- H. Power Supplies: Provide one of the following power supplies that are manufacturer-prepared to support Mercury Security and HID VertX EVO hardware.
 - 1. LifeSafety Power: Enclosures, Kits, and Power Supplies.
- I. US Federal Government FICAM Solution:
 - 1. HID pivCLASS Software Suite.
 - 2. HID pivCLASS PAM.

3. HID pivCLASS Readers.
4. Mercury Embedded LP4502.

2.5 ACCESS CONTROL SOFTWARE INTERFACE

- A. Web-Based Access Support: Provide access control software with browser-based access to system applications including support for industry standard desktop and mobile web browsers.
- B. Tabbed User Interface: System supports the following functionality in a tabbed view:
 1. Monitor events, alarms, and hardware status in real time.
 2. Verify identifies in real time.
 3. Search historical events and alarms.
- C. Events and Alarms: Provide system that allows administrators the ability to create, configure, and prioritize events and alarms and communicate information about the generation of the event or alarm to the operator with guidance for responding to the event or alarm. Events will support two levels: system level events affect all objects in the system; field level events affect only the object they are configured on.
- D. Access Groups: Provide system that allows administrators the ability to create groups of card readers and schedules such that card readers can allow or restrict access to areas based on schedules.
- E. Identity Records: Provide a system with integrated identity management, allowing imports of data from supported databases. Each identity supports access control based on groups and roles as well as individual overrides. Include functionality to customize identity and token forms in base software. Provide identity records capable of management and synchronization between multiple sites.
- F. Roles: Support a role-based permission method allowing one or more roles to be assigned to identities to determine physical and logical access.
- G. Anti-Passback: Provide access control software capable of designating areas to require a card to enter and exit the area before it is used to enter the area again.
 1. Soft and Hard Area APB: Tracks each badge that enters a specific area and defines which areas the badge may access next.
 2. Door-Based APB: Tracks each badge that enters and does not allow the same badge to enter twice in a row until after the APB time limit is reached.
 3. Token-Based, Timed APB: Tracks each door a badge has accessed. After the badge has accessed one door, it must access a second door or wait until the APB time limit is reached before it may access the first door again.
 4. Timed Area APB: Time based hard area APB. When the time limit expires, the hard area APB becomes a soft area APB.
 5. Hard Door APB: Tracks each badge that enters a door and does not allow the same badge to enter twice in a row.
 6. Soft Door APB: Tracks each badge that enters a door and generates a warning transaction if the same badge is used at the same door twice in a row.

- H. Badging: Provide a tool to support the creation of custom badge layouts including the following content:
 - 1. Static Information: Badge size, background color, text strings, and graphics common to every badge.
 - 2. Dynamic Information: Text fields and images from the identities database unique to each badge.
- I. Enrollment: Provide integrated identity management and enrollment functionality as part of the core system functionality.
 - 1. Includes integration with HID Origo Credential Management or deployment of Origo mobile credentials directly from the access control web interface
- J. Macros: Provide system capable of linking one or more events to macros such that a single event may execute up to 30 macros. System must support minimum of 255 macros per intelligent field controller.
- K. Device Template Configuration: Provide access control system that supports templates to automatically populate standard parameter fields in groups for new or existing doors, wires, readers, and input/output devices.
- L. Encryption: Provide access control system that supports the following encryption methods:
 - 1. TLS 1.2: Require TLS encryption between the access control system and Mercury controller.
 - 2. Custom Certificates: Require self-signed or certificate authority certificate to harden access control system. Certificates will authenticate Mercury panels to the access control system.
 - 3. FIPS 140-2: Require access control server to utilize FIPS 140-2 compliant ciphers only.
 - 4. FIPS 201-2: Require large-encoded card formats for FIPS 201-2 certified pivClass readers.
- M. Custom Device Mappings: Administrators may assign a unique group of alarm attributes to specific device-alarm combinations to override global settings of generic attributes.
- N. Dashboard: Allow creation of a dashboard for real-time status and actions of hardware components on a single screen that can also filter by name, status, appliance, or group.
 - 1. Hardware Status:
 - a. Panels: Communication, power, tamper, and battery.
 - b. Sub-Panels: Communication, power, and tamper.
 - c. Inputs: Inactive, active, trouble, and masked.
 - d. Outputs: Off, on, and trouble.
 - e. Doors: Communication, tamper, battery, unlocked, help, masked, and forced.
 - f. Appliances: RAM, program, database, CPU load, and port status.
 - 2. Monitor:
 - a. Panels: Device status, security status, name, model, firmware, IP address, MAC address, access port, callback port, cards in use, and last communication.
 - b. Sub-Panels: Device status, name, panel, type, port, address, and firmware.
 - c. Inputs: Device status, input name, subpanel, EOL resistance, and address.
 - d. Outputs: Device status, output name, subpanel, schedule, and address.
 - e. Power Supplies: Power supply name, installed status, status, and logs.

- f. Access Control Doors: Status, name, panel, door state, door mode, and override status.
 - 3. Manipulate Access Control Doors:
 - a. Door actions: Grant, restore, unlock, locks no access, disable.
 - b. Door mode: Card only, card and PIN, card or PIN, PIN only, facility code only, exit leaves open, toggle + exit leaves open.
 - c. Door Forced: Mask forced, unmasked forced.
 - d. Door Held: Masked held, unmasked held.
 - e. Installed: Install, uninstall.
- O. Map Interface: Provide interface for creating customizable layouts including floorplans, reader locations, and buttons that can trigger actions.
 - 1. Actions: Card readers indicate alarm via icon and allow for card only, card and pin, card or pin, pin only, facility code only, disable, unlock, lock, grant, restore, mask held, unmask held, and trace actions.
 - 2. Occupancy/Mustering: Maps will provide real-time occupancy of a defined area.
 - 3. Programmable Buttons: Maps will provide mapping of buttons and text to perform actions.
- P. Verification Interface: Provide web-browser-enabled connection to access control software allowing a user to review information about card holders entering or existing up to four (4) doors in real time. Information to include badge photo, transaction time, and date via any device with a compatible browser.
- Q. Virtual Verification Station: Provide web-browser-enabled connection to the access control software to allow a user to visually confirm the identity and authorization of a person attempting entry to a controller area via a mobile device such as a tablet or smartphone.
- R. Intrusion Interface: Provide interface to see real-time status of linked Intrusion Panels.
 - 1. Display Intrusion Panels with following status:
 - a. Communication, Battery, Power, Tamper, Phone Line.
 - 2. Display and Interact with Configured Areas.
 - a. Status, Area Name, Panel Name.
 - b. Silence, Disarm, Master, and Perimeter.
 - 3. Display and Interact with Intrusion Points.
 - a. Status, Point, and Area.
 - b. Bypass and Un-bypass.
 - 4. Display and Interact with Intrusion Output.
 - a. Status, Outpoint, Panel.
 - b. Activate and Deactivate.
- S. Access Control Software Reporting: Generate, filter, edit, and customize system reports including the automated generation and distribution of customized reports in PDF and CSV formats.

2.6 ACCESS CONTROL MOBILE APPLICATION

- A. Access control platform must have a mobile app (ACM Expedite) on the following platforms:

1. Apple App Store
2. Google Play Store

- B. Access control platform mobile app must have the following features
1. Execute global actions with a single click for situations like lockdown.
 2. Trigger schedule changes
 3. Lock Doors
 4. Connection to multiple access control systems.

2.7 ACCESS CONTROL SOFTWARE VIDEO INTEGRATIONS.

- A. Refer to 28 05 45 Systems Integration and Interconnection Requirements.
- B. Video Management System Unification: Provide the following features in video management system when used in conjunction with access control software.
1. Link cameras and doors on a single screen.
 2. Search video by card swipe using identity search.
 3. Grant door access.
 4. Monitor live door swipes with video for identity verification.
 5. Display video and alarm information in video management client.
- C. Access Control System: Provide following features in access control software when used in conjunction with video management system.
1. Link cameras and doors to specific events.
 2. Notifications for events includes live video and recording of even from before and after in web browser interface.

2.8 ACCESS CONTROL SOFTWARE ADMINISTRATION

- A. Backup: Provide access control software capable of backing up via USB drive, local appliance, windows network share, or secure copy protocol.
- B. Database Replication: Replicate database from 1 to 100 appliances for distributed identity control.
- C. Password Update: Provide ability for administrator to request operator update password at next login.
- D. Failover and Redundancy: Provide access control software that supports switching to backup system automatically in the event of a fatal failure without loss of monitoring or hardware control.
1. Provide failover technology supporting LDAP data replication.
 2. Provide failover technology supporting either a 1:1 or N:1 architecture.
- E. Updates: Provide access control software capable of automatically updating the following:
1. Operating System: Version, service packs, and security vulnerabilities.
 2. Field Devices: Firmware versions.

- F. Upgrade Functionality: Provide access control software capable of automatically upgrading software licensing.

2.9 ACCESSORY SOFTWARE SCHEDULE:

- A. Reader Licensing:
 - 1. Additional Readers: AC-SW-LIC-16RCU-6-P; perpetual, adds 16 reader software licenses to any appliance to expand door capacity up to the appliance's maximum capacity.
- B. Badging Application Software Licenses:
 - 1. Badging Application: AC-SW-LIC-BDGE-6-P; perpetual, one per appliance.
- C. Intrusion Integration Licenses:
 - 1. Bosch: AC-SW-LIC-BOSCHINTR-1PANEL-6-P; perpetual, per panel, one per appliance.
 - 2. Bosch: AC-SW-LIC-BOSCHINTR-10PANEL-6-P; perpetual, for 10 panels, one per appliance.
- D. Verify Integration Licenses:
 - 1. Verify: AC-SW-LIC-AVO-VER-5VS-6-P; perpetual, for five virtual stations, one per appliance.
 - 2. Verify: AC-SW-LIC-AVO-VER-16VS-6-P; perpetual, for sixteen virtual stations, one per appliance.
- E. Biometric Integration Licenses:
 - 1. VIRDI: AC-SW-LIC-VIRDI-BIO-6-P; perpetual, for Viridi Biometric readers, one per appliance.
- F. Redundancy and Failover Software Licenses
 - 1. Replication: AC-SW-LIC-REP-6-P; for multi-appliance replication, one per appliance.
 - 2. Auto Failover: AC-SW-LIC-AF-6-P; hot standby auto failover software license, one per appliance.
 - 3. Partitioning: AC-SW-LIC-PART-6-P; for additional partitions, one per appliance.
- G. IT Collaboration Software Licenses:
 - 1. Microsoft SQL: AC-SW-LIC-SQL-6-P; from Microsoft SQL Server 2000 forward, one per appliance.
 - 2. Oracle: AC-SW-LIC-ORCL-6-P; from Oracle DB 9i Server forward, one per appliance.
 - 3. LDAP Directory: AC-SW-LIC-LDAP-6-P; for Microsoft Active Directory or other, one per appliance.
 - 4. XML: AC-SW-LIC-XML-6-P; for XML events, one per appliance.
 - 5. REST: AC-SW-LIC-REST-6-P; perpetual, for unlocking REST-based API for custom integrations, one per appliance.

2.10 ACCESSORY HARDWARE SCHEDULE

- A. Panels:

1. Mercury: Controllers; Series 3 (LP1501, LP1502, LP2500, and LP4502).
 2. Mercury: Controllers; Series 2 (EP1501, EP1502, and EP2500).
 3. Mercury: Controllers; Legacy (SCP, SCP-C, and SCP-E).
 4. Mercury: Sub Panels; MR50, MR52, MR16IN, MR16OUT, MR51E, and MR62E).
 5. Mercury: Conversion Boards; M5 Bridge.
 6. Mercury: Conversion Boards; MS Bridge.
 7. HID: Controllers; V2000 and V1000.
 8. HID: Sub Panels; V100, V200, and V300.
 9. Salto: Controllers; CU42E0XXX and CU4200XXX via SALTO SHIP integration to Pro Access Space.
- B. Enclosures:
1. Life Safety Power: Mercury Security.
 2. Unified Power: Mercury Security; 2/4/8/16/24 Door Enclosures with or without network module.
 3. Unified Power: Mercury Security; ProWire Pre-Wired Power.
 4. Unified Power: Mercury Security; Tie Wrapped 4/8/16 Door Enclosures.
 5. Unified Power: Mercury Security; Panduit 8/16/24 Door Enclosures with or without Network Module
 6. Unified Power: Salto; 4/6/8/10 Door Enclosures with or without network module.
- C. Readers:
1. HID: Prox.
 2. HID: R Series.
 3. HID: Signo.
 4. Allegion: Schlage Series.
 5. Farpointe: Pyramid.
 6. Farpointe: Delta.
 7. Farpointe: Conekt.
 8. Salto: XS4 Readers via SALTO SHIP integration to Pro Access Space.
- D. Wireless Locks and Peripherals:
1. Allegion/Schlage: AD300.
 2. Allegion; Schlage: AD400.
 3. Allegion; Schlage: NDE[B].
 4. Allegion; Schlage: LE[B]MS.
 5. Allegion; Schlage: LE[B]MB.
 6. Allegion; Schlage: Control Smart Deadbolt (BE467F, FE410F).
 7. ASSA ABLOY: Aperio Line of Devices
 8. ASSA ABLOY Wi-Fi & POE via integration to DSR
 9. Salto: Salto Systems: Locks via SALTO SHIP integration to Pro Access Space.
 10. SimonsVoss: SmartIntego Series.
 11. Schlage: LEB via RS-485.
 12. Schlage: NDEB via RS-485.
- E. Crash Bars:
1. Von Duprin: RU & RM Crashbar retrofit kits.

PART 3 EXECUTION

3.1 PREPARATION

- A. Prior to installation, ensure Access Control Hardware Appliance is capable of required Access Control Software Features and Integrations.

3.2 INSTALLATION

- A. Install system according to manufacturer's written instructions.
 - 1. Develop, install, and test software and databases for complete and proper operation of systems involved. Activate and install all software and accessory software licenses.
 - 2. Setup and program entire system so that no additional programming is required after Substantial Completion, including setup of available software features.
 - 3. Perform a full system back-up at completion of initial programming and deliver configuration and transaction backups to Owner.
 - 4. Perform field software changes after the initial programming session to "fine tune" operating parameters and sequence of operations based on revisions to the Owner's operating requirements including the creation of time schedules, holidays, new card formats, etc. Create user hierarchy with access permissions. Set up notifications.
 - 5. Test equipment and configure system in accordance with instructions provided by manufacturer prior to installation.
- B. Ensure products are equipped with latest and most up-to-date firmware and/or software by manufacturer.
- C. Review configurable features of device with Owner's Representative and establish a punch list for standard, device specific, location specific and access control software-specific configuration of device(s).
- D. Program and configure devices in accordance with this punch list so no additional programming is required for operation by user.
- E. Configure equipment requiring users to log on using a password with user/site-specific password/passwords.
- F. No system/product default passwords allowed.

3.3 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. Demonstrate administration and operation of access control system.
 - 2. Demonstrate how an authorized user can log in and make changes to configuration of card holders, door access, and run reports.
 - 3. Demonstrate how to operate functionality configured for this project as defined by configuration punch list.

- B. Fine Tuning:
 - 1. Perform field software changes after initial programming session to “fine tune” operating parameters and sequence of operations based on any revisions to Owner’s operating requirements.
- C. License Assignment:
 - 1. Register software, hardware, firmware, operational or administrative licenses necessary for to operate or administer devices to Owner including the end user license agreement (EULA).
 - 2. Deliver to Owner’s Representative proof of license registration from product manufacturer.
- D. Device Configuration Backup:
 - 1. Using access control system backup functionality, perform a full system backup at the completion of the initial programming to a USB drive or customer local network shared folder (preferred option). Schedule backup function to execute system backup periodically.
 - 2. Deliver configuration backup files, restoration application and instructions detailing for restoration of back-up configuration.

END OF SECTION 281400

**SECTION 283100 - FIRE ALARM & EMERGENCY VOICE COMMUNICATIONS SYSTEM
(Addendum 2)**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of Contract, including General and Supplementary Conditions and other General Requirements sections, apply to the work specified in this section.

1.2 WORK DESCRIPTION:

- A. Provide a Simplex Brand 4100 ES Emergency Communication Voice Alarm FACU in accordance with the attached Construction Bid Drawings and Specifications. It is the intent of these specifications to complete a multi-phase expansion of the existing Simplex Fire Alarm as shown on the Project Drawings to maintain compatibility and listing with all other existing Simplex Brand Fire Alarm equipment currently installed. All new initiating device circuit work shall use Simplex addressable material and IDNet addressable SLC communications. New Visuals shall be synchronized and Audible Signals shall be Voice Alarm capable. Simplex Brand is sold and supported by Johnson Controls JCI.
- B. The system shall include new devices in accordance with the project drawings consisting of new controls, pull stations, smoke/heat/duct sensors, annunciator panel, audio visible units, visible only units and any other appurtenances necessary for complete and operational system.
- C. The complete installation is to conform to the applicable sections of the current IBC, NFPA-72, NFPA-70 (with particular attention to Article 760), and any other locally enforced requirements of the Authority Having Jurisdiction.

1.3 QUALITY ASSURANCE:

- A. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the UJOZ category by Underwriters Laboratories, Inc. (UL), and shall bear the "U.L." label. Partial listing shall NOT be acceptable.
- B. The catalog numbers specified under this section are those of Simplex Time Recorder and constitute the type, product quality, material, and designed operating features. No substitutions will be accepted.

1.4 SHOP DRAWINGS:

- A. The contractor shall submit a package which is sufficiently detailed to show that the proposed system meets the specifications. The package shall contain the following:
 - 1. Catalog cuts of components, including system cabinets with physical dimensions.
 - 2. Circuited Floor Plans showing the types and arrangement of connections among the components, including cable types.
 - 3. Tabulations verifying the extra capacity required below. Show tabulations for points, power supplies, and battery standby.
 - 4. Without these, the package will be rejected without review.
- 1.5 WARRANTY:
 - A. The Contractor shall guarantee the system to perform as specified and be free from defects in materials and workmanship for one year from date of Owner acceptance. Any repairs during this time are to be provided by the Contractor during normal working hours at no cost to the Owner.
- 1.6 OPERATION:
 - A. The actuation of any alarm initiating device such as a manual pull station, fire sensor or sprinkler flow switch shall cause the following to occur:
 - 1. Sound all audible and visual alarm signals until manually acknowledged and reset.
 - 2. Display the device in alarm label at the control panel.
 - 3. Display the device in alarm label at the annunciator panel if supplied.
 - 4. Transmit the alarm to an approved supervising station via internal DACT or Alarm Relay Module.

PART 2 - PRODUCTS

- 2.0 Approved Manufacturers: Basis of Design Simplex by Johnson Controls
 - 1. Approved Alternates:
 - a) None
- 2.1 MAIN PANEL:
 - A. Fire Alarm Master Controller CPU: Modernize and expand the existing Fire Alarm Controls adding additional modules and enclosures as necessary. Where required demolish and/or consolidate existing legacy controls into modern 4100 U/ES type enclosures. At a minimum provide and power as noted the following in quantities necessary to complete the project:
 - 1. 4100-9111 Simplex 4100 U/ES System Master Controller
 - 2. 4100-9621 Simplex 4100 U/ES Digital Audio w/Microphone
 - 3. 4100-5101 Simplex 4100 U/ES expansion power supply.
 - 4. 4100-1329 Simplex 4100 U/ES 100 W Digital Amplifier.
 - 5. 4100-XXXX Related Support Modules as appropriate.

2.2 SYSTEM COMPONENTS

- A. Both Initiating and Notification material supplied shall be addressable whenever possible. Where specified as “Fire Alarm Only” supply notification appliances labeled FIRE as opposed to ALERT. Where specified non-voice alarm supply appropriate equivalent tone only device. Consult the Johnson Controls representative regarding substitutions and appropriate equipment selections.
- B. Addressable TrueAlert Speaker/Visual Combination Alarm: Simplex 49SV-APPL (C or W) with 49SVC- (CW or WW) designate ALT for ALERT Cover.
 - 1. White housing with a clear lens, wall-mount
 - 2. Fully synchronized per ADA and UL Standard 1971
 - 3. Individually addressable point control of both Visible and Audible operation
 - 4. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110/135/185 cd))
 - 5. High quality voice and tone reproduction with multi-tap and capacitor input connection.
 - 6. Surface-mount adapters where required (4905-9947)
 - 7. Wire guards where indicated (4905-9998)
- C. Addressable TrueAlert Speaker Alarm: Simplex 49SO-APPL (C or W) with 49SOC- (CW or WW) designate ALT for ALERT Cover.
 - 1. Off-white housing, ceiling-mount
 - 2. Individually addressable point control of Audible operation
 - 3. High quality voice and tone reproduction with multi-tap and capacitor input connection.
- D. Addressable TrueAlert Visual Alarm: Simplex 49VO-WWA or 4906-9204
 - 1. White housing with a clear lens, wall-mount
 - 2. Individually addressable point control of Visible operation
 - 3. Fully synchronized per ADA and UL Standard 1971
 - 4. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110 cd))
 - 5. Surface-mount adapters where required (4905-9940)
 - 6. Wire guards where indicated (4905-9961)
- E. Addressable TrueAlert Visual Alarm for Weather-Proof: Simplex 49VO-APPLW-O with 49VOC-WRALT-O ALERT Cover.
 - 1. Red housing with a clear lens, wall-mount
 - 2. Individually addressable point control of Visible operation
 - 3. Fully synchronized per ADA and UL Standard 1971
 - 4. Strobe intensity shall be as indicated or required by the application (20/ 30/75cd))
 - 5. Surface Mount Weather-Proof Box (49WPBB-AVVOWR)
- F. Conventional TrueAlert Speaker/Visual Combination Alarm: Simplex 4906-9153 with 4905-9846 Cover
 - 1. White housing with a clear lens, wall-mount

2. Fully synchronized per ADA and UL Standard 1971
 3. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110 cd))
 4. High quality voice and tone reproduction with multi-tap and capacitor input connection.
 5. Surface-mount adapters where required (4905-9947)
 6. Wire guards where indicated (4905-9998)
- G. Conventional TrueAlert Speaker Alarm: Simplex 4902-9721 with 2905-9946 Tile Bridge
1. Off-white housing, ceiling-mount
 2. High quality voice and tone reproduction with multi-tap and capacitor input connection.
- H. Conventional TrueAlert Visual Alarm: Simplex 4906-9103 with 4905-9842 Cover
1. White housing with a clear lens, wall-mount
 2. Fully synchronized per ADA and UL Standard 1971
 3. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110 cd))
 4. Surface-mount adapters where required (4905-9940)
 5. Wire guards where indicated (4905-9961)
- I. Conventional TrueAlert Visual Alarm for Weather-Proof: Simplex 4906-9105
1. Red housing with a clear lens, wall-mount
 2. Fully synchronized per ADA and UL Standard 1971
 3. Strobe intensity shall be as indicated or required by the application (15/ 60/75cd))
 4. Surface Mount Weather-Proof Box (4905-9828)
- J. Conventional Audible for Weather-Proof: ET-1010 with SBB-R Back Box
1. Red housing.
 2. High quality voice and tone reproduction with multi-tap and capacitor input connection selectable (1/8, 1/4, 1/2, 1, 2, 4, 8 Watt @ 70.7 Volt).
- K. Conventional TrueAlert Loudspeaker for Wide Area Indoor/Outdoor
1. Where a single loudspeaker device is specified for wide area audible notification operation supply Simplex 49OMNI-05-A. Device shall be tapped at 100 Watt / 70.7 Volt
- L. Eaton Wheelock Audible for Weather-Proof: ET-1010 with SBB-R Back Box
1. Red housing.
 2. High quality voice and tone reproduction with multi-tap and capacitor input connection selectable (1/8, 1/4, 1/2, 1, 2, 4, 8 Watt @ 70.7 Volt).
- M. Eaton Wheelock Directional Loudspeaker: STH-15SR with SHMP-R Plate
1. Red housing.
 2. High quality voice and tone reproduction with multi-tap and capacitor input connection selectable (0.9, 1.8, 3.8, 7.5, 15 Watt @ 70.7 Volt).

- N. IDNet Addressable Pull Station for ADA approved operation; Simplex #4099-9020
 - 1. Single-action operation with ADA approved pull-to-operate actuation mechanism
 - 2. Red Lexan housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 - 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 - 4. Surface Mount supply Box (2975-9178)
 - 5. Wire guards where indicated (2099-9800)
- O. IDNet Addressable Pull Station for Rugged/Vandal; Simplex #2099-9138 with 4090-9051
 - 1. Single-action operation with pull-to-activate lever
 - 2. Red cast metal housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 - 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 - 4. Surface Mount supply Cast Aluminum Box (2975-9211)
- P. IDNet Addressable Pull Station for Weather-Proof; Simplex #2099-9144 with 4090-9051
 - 1. Single-action operation pull-to-activate lever
 - 2. Red cast metal housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 - 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- Q. Detection Devices – General
 - 1. Sensors shall include analog sensing and addressable communication, and shall connect to the fire alarm control panel's Signaling Line Circuits.
 - 2. Sensors shall mount to the same addressable base which includes a status indicator LED.
 - 3. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system.
 - 4. The sensors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature. Provide surface-mount adapter plate where required.
 - 5. The sensors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
- R. TrueAlarm Smoke Sensor (Photoelectric): Simplex #4098-9714
 - 1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
 - 2. Supply Standard Addressable Base Simplex #4098-9792 or Simplex #4098-9794 where Piezo Electric Sounder is specified.
- S. TrueAlarm Heat Sensor (Thermal); Simplex #4098-9733E

1. Thermal detectors shall be intelligent addressable devices rated to operate at 135 or 155 degrees Fahrenheit and be field-selectable with or without a rate-of-rise element rated at 15 degrees F per minute.
 2. Supply Standard Addressable Base Simplex #4098-9792E.
- T. TrueAlarm Multi-Sensor (Photoelectric with Thermal): Simplex #4098-9754
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Thermistor shall be self restoring and rate compensated.
 2. Supply Multi-Sensor Addressable Base Simplex #4098-9792 or Simplex #4098-9794 where Piezo Electric Sounder is specified.
- U. TrueAlarm Multi-Sensor (Photoelectric with Carbon Monoxide): Simplex #4098-9714/9746
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Electrolytic CO Toxic Gas Sensor.
 2. Supply CO Addressable Base Simplex #4098-9797 or Simplex #4098-9798 where Piezo Electric Sounder is specified.
- V. Air Aspiration Smoke Sensor: Simplex #VLC-600 with 2098-9808 Remote Status LED
1. Laser Detection Chamber type, featuring a high efficiency aspirator continually sampling air through a filtered transport system.
 2. The Housing shall be compact in size measuring 8-7/8" square and enclose the entire TrueAlarm Laser COMPACT sensor.
- W. Duct Smoke Sensor: Simplex #4098-9756 with 2098-9806 Test Station
1. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
 2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Mount relay within 3 feet of HVAC control circuit.
 3. Duct Housing shall have a transparent cover to monitor for the presence of smoke and a relay control trouble indicator Yellow LED and Red sensor status LED.
 4. Duct Housing shall include two (2) Test Ports for measuring airflow and for testing.
 5. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to shutdown associated air handling system.
 6. Each duct detector shall have a Remote Test Station with an alarm LED and test switch located where indicated.
 7. Weatherproof Enclosure if indicated (4098-9845)
- X. Addressable Interface (Monitor) Module; Simplex #4090-9001
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

2. The monitor module shall mount in a standard single-gang electrical box. Provide mounting bracket and cover plate with LED view port
 3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
 4. Supply mounting bracket Simplex # 4090-9810 with cover plate with LED light pipe for viewing Simplex # 4090-9807.
- Y. Addressable Relay (Control) Module; Simplex # 4090-9002
1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
 2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
 3. Supply cover plate with LED light pipe for viewing Simplex # 4090-9802
- Z. Addressable Multi-Point Module (HVAC Dampers and other); Simplex # 4090-9118
1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires. The input shall support the supervised monitoring of normally open, dry contacts in a "T-Sense" configuration.
 2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
 3. Supply cover plate with LED light pipe for viewing Simplex # 4090-9802
- AA. Non-Simplex Brand Components – General
1. Under certain circumstances the devices of other Manufacturer's may be required to satisfy environmentally challenging or special applications.
 2. Conventional Heat Detection shall be products as manufactured by System Sensor.
 3. Weatherproof Conventional Heat Detection shall be products as manufactured by Fire Detection Devices.
 4. Linear Heat Detection Cable shall be products as manufactured by Protectowire or SafeCable.
 5. Toxic Gas Detection shall be products as manufactured by MSA or Macurco.
 6. Photo-Beam Detection shall be products as manufactured by Fire Fighting Enterprises or Xtralis.
 7. These system Inputs shall be supervised as Conventional Initiating Device Zones via Panel Module or Addressable Module.
 8. Weather Resistant/Proof Signaling shall be products as manufactured by Cooper Notification.
 9. NEMA 4X Signaling shall be products as manufactured by MEDC.

10. Aftermarket add-on Relays shall be products as manufactured by Air Products and Controls.

BB. Remote Annunciator Panel; Simplex # 4100-940X

1. Supervised remote annunciator with same look and feel as Primary Control Display including audible and visual indication of fire alarm by device, and audible and visual indication of system trouble.
2. Multi-line expanded content 320x240 dot matrix (QVGA) active event display screen with Bright white LED backlighting capable of displaying up to 854 characters.
3. English display: Indicates system normal with date and time during normal operation. Indicates type of alarm or trouble exact device with location, number of alarms with scrolling capability and supervisory conditions.
4. Six dedicated LED indicators: Power on, Alarm silence, System trouble, System supervisory, and Two alarm LED's.
5. Password protected.
6. LCD/lamp test button.
7. Control buttons: Alarm acknowledge, Supervisory acknowledge, Trouble acknowledge, Alarm silence. System reset, Scrolling next and previous, Seven programmable buttons for customized usage.
8. Mounting: Factory mounted in surface wall-mounted cabinet enclosure with key access. Simplex Red finish.

CC. Small Form Voice Command Remote Annunciator Panel; Simplex # 4100-940X

1. Supervised remote annunciator with same look and feel as Primary Control Display including audible and visual indication of fire alarm by device, and audible and visual indication of system trouble.
2. Multi-line expanded content 320x240 dot matrix (QVGA) active event display screen with Bright white LED backlighting capable of displaying up to 854 characters.
3. English display: Indicates system normal with date and time during normal operation. Indicates type of alarm or trouble exact device with location, number of alarms with scrolling capability and supervisory conditions.
4. Six dedicated LED indicators: Power on, Alarm silence, System trouble, System supervisory, and Two alarm LED's.
5. Password protected.
6. LCD/lamp test button.
7. Control buttons: Alarm acknowledge, Supervisory acknowledge, Trouble acknowledge, Alarm silence. System reset, Scrolling next and previous, Seven programmable buttons for customized usage.
8. Cabinet Mounted Remote Microphone 4003-9803
9. Mounting: Mounted in surface/semi-flush wall-mounted cabinet (YM0356) enclosure with key access. Enclosure access door shall deliver with painted label FIRE ALARM EMERGENCY COMMUNICATION SYSTEM LOCAL OPERATING CONSOLE. Simplex Red finish with white lettering.

DD. System Expansion Transponder; Simplex # 4100-96XX

1. System hardware expansion shall occur collocated or remote of the Fire Alarm Master Controller using only system Transponders based on the same controls and enclosures used by the FACP.

2. System Expansion Transponder shall be Simplex 4100 ES MINIPLEX Type 4100-9600 Series.
3. Expansion Power Supplies shall be 4100 ES Type EPS, SPS, RPS, XPS, or TPS as dictated by the project requirements.
4. System Audio Expansion shall use the same 4100 ES Amplifier type as the Master Controller.

2.3 BATTERIES AND EXTERNAL CHARGER

- A. Battery; Simplex # 2081-XXXX
 1. Shall be 12 volt, Gel-Cell type.
 2. Shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 15 minutes of alarm upon a normal AC power failure.
 3. The batteries are to be completely maintenance free.
- B. Battery Charger; Simplex# 4081-XXXX
 1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt source.
- C. Enclosure; Simplex# 4081-XXXX
 1. Shall be of adequate volume to support external mounting of the battery reserve. Coordinate with supplier for proper selection and supply as necessary.

2.4 SPARE DEVICES; Simplex# BESAFEADDR

- A. Provide the spare devices listed below in addition to all quantity of devices indicated on drawings. Deliver devices to Owner at conclusion of project.
 1. One (1) sensor of each type
 2. One (1) sensor base of each type
 3. One (1) manual pull station of each type
 4. One (1) interface module
 5. One (1) control module
 6. Two (2) speaker-visual devices
 7. One (1) visual device
- B. Extra material to be stored in a manufacturer approved and supplied spare parts kit. The enclosure shall be of adequate interior volume, be clearly labeled as to contents, and installed by the contractor in a readily accessible location for routine service activities.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NFPA 72, local and state codes, as shown on the drawings, and as recommended by the equipment manufacturer.
- B. Device Mounting: All fire detection and alarm system devices, control panels and remote annunciators shall be installed as follows:
 - 1. Accessible ceilings (lay-in ceilings or suspended drywall or similar construction)
 - a. flush mounted devices with recessed box and concealed wiring/conduit
 - 2. Inaccessible ceilings (exposed 'open' structure or inaccessible ceilings)
 - a. unfinished spaces; surface mounted devices using exposed conduit and boxes
 - b. finished spaces; surface mounted devices using surface raceway
 - 3. Hollow walls (stud walls or hollow CMU)
 - a. flush mounted devices with recessed box and concealed wiring in conduit
 - b. surface devices with exposed conduit may be used only in unfinished spaces (mechanical / electrical rooms or similar areas).
 - 4. Solid walls (solid masonry)
 - a. surface mounted devices with surface raceway system
 - 1) exposed conduit may be used only in unfinished spaces (mechanical / electrical rooms or similar areas).

3.2 WIRING METHODS

- A. General: All fire alarm system wiring shall be installed concealed wherever possible.
 - 1. Install wiring in cable tray where indicated. Use an approved cable support system attached directly to structure elsewhere.
 - 2. No wiring shall lie directly on ceilings. No wiring shall be strapped or tied to piping, ductwork or conduits.
 - 3. In open structure areas (rooms without ceilings) install wiring in conduit.
- B. Conduit and Raceway:
 - 1. Conduit shall be electrical metallic tubing, $\frac{3}{4}$ " minimum, with fittings and boxes.
 - 2. All conduit and junction boxes shall be concealed in finished areas and may be exposed in unfinished areas or areas without ceilings.
 - 3. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer
 - 4. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
 - 5. All conduit, mounting boxes, junction boxes and panels are to be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.
 - 6. Fire alarm cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

7. Conduit sleeves with fire-stopping shall be provided where open wiring penetrates floors or fire-rated partitions.

C. Wiring:

1. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system.
2. All fire alarm system wiring and cables must be new and be color-coded red
3. Number and size of conductors or cables shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and signaling line circuits, and 14 AWG for notification appliance circuits.
4. Wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
5. Wire and cable not installed in conduit shall have a plenum-rated fire resistance rating as indicated in NFPA 70 (e.g., FPLR).
6. Conductors in conduit shall be type THHN or THWN insulated as specified in other Section 260519,
7. Wire and Cable shall be as recommended by the equipment manufacturer and approved for use as a Fire Alarm Cable by the National Fire Code and the local authority. Where exposed all circuits shall be enclosed in EMT or better. Installation shall follow Section 16100.
8. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This panel circuit breaker shall be labeled as FIRE ALARM in "RED" and be provided with a "RED" Circuit Breaker Lock, Garvin UBL2 or equivalent. The control panel shall be grounded using a #10 AWG conductor.
9. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
10. All field wiring shall be electrically supervised for open circuit and ground fault.
11. All conductors and cables shall be installed without the use of splices unless permitted by the manufacturer.
12. Cable lubricants shall be used only as permitted by the manufacturer.
13. Flexible connectors are to be used for all devices mounted in suspended lay-in ceiling panels.
14. No wiring other than fire alarm detection, alarm or auxiliary functions will be permitted in fire alarm raceways.

D. Terminal Boxes, Junction Boxes and Cabinets

1. All boxes and cabinets shall be factory painted red and UL listed for their use and purpose. Suppliers of such material include Arlington Industries, Bridgeport, Garvin, and Space Age Electronics.

- E. The contractor shall supply two Category VI Cables between the customer's primary network service switch and the FACP to support IP Based Remote Service Monitoring and Reporting. Cables shall be certified to meet the ANSI/TIA -568-B.2-1 Standard for Gigabit Ethernet. Only 22 or 23 AWG copper shall be allowed.

3.3 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Equipment Mounting: Install fire-alarm control unit on utility strut to provide an air-space from the wall surface if mounting on an exterior masonry wall.
 - 1. Install seismic bracing. Comply with requirements of "Vibration and Seismic Controls for Electrical Systems."
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (460-mm) centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Equipment Mounting: Install fire-alarm control unit on finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in "Vibration and Seismic Controls for Electrical Systems."
- D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in "Vibration and Seismic Controls for Electrical Systems."
- E. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- F. Smoke-or-Heat Detector Spacing:
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed 30 foot spacing.

4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- G. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
 2. Duct Smoke Detector shall be equipped with Remote Test Switches. Test Switches shall be installed in the ceiling below the Roof Top Unit they support if applicable.
- I. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.
- J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in elevator shafts, unless the shaft is protected by an Automatic Sprinkler System installed in accordance with NFPA 13.
- K. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- L. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- M. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes. Install all devices at the same height unless otherwise indicated.
- N. Visible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install such that the center line of the Visible Alarm Device is 80" above the finished floor surface. Install all devices at the same height unless otherwise indicated.
- O. Alarm Network Communications:
1. Digital Alarm Communicator and TCP/IP communications cable as specified in 2.3 J. 2. & 4. shall be Category 6 Plenum Rated Type. Cables shall be certified to meet the ANSI/TIA -568-B.2-1 Standard for Gigabit Ethernet. Only 22 or 23 AWG copper shall be allowed. Work shall be completed in conformance with accepted Voice and Data installation practices.

P. Identification:

1. All wiring shall be identified at the FACP and at each terminal and junction box. Each conductor and cabinet terminal must be numbered and coded. All conductors in conduit pull boxes or cabinets containing more than one wire must be labeled on each end with machine printed on flexible high adhesion vinyl tape.
2. Wiring color codes must be used throughout. Transposing or changing color coding of wires will not be permitted.
3. Junction boxes shall be painted fire red and identified with 'FA' on cover. Suppliers of such material include Arlington Industries, Bridgeport, Garvin, and Space Age Electronics.

Q. Smoke detectors and pull stations shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect devices from contamination and physical damage

3.4 COORDINATION

- A. Coordinate with all other trades in submittal of shop drawings. Shop drawings shall detail space conditions to the satisfaction of all concerned trades, subject to final review by the architect or project manager whichever is applicable. If installation of equipment, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades, make necessary changes to correct the condition at no additional cost to the owner.
- B. Maintain all existing equipment and systems in operation until new equipment and systems are installed, tested and made operational as required, to follow phasing of construction.
- C. Coordinate and disconnect existing electronic/electrical equipment, services and/or controls to items being removed.

3.5 TEST

- A. Provide the service of a competent, factory-trained project manager NICET Level IV and technician NICET Level II minimum authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 3. Verify activation of all flow switches.
 4. Open and ground initiating device and signaling line circuits and verify that the trouble signal actuates.
 5. Check presence and audibility of tone and voice message at all alarm notification devices.
 6. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.

7. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
8. Test optional features based on the manufacturer's instructions.

- B. After certification of completion and operation of the system, the entire system shall be retested by the manufacturer's representative in the presence of a representative of the owner and the Authority Having Jurisdiction, and a test report per NFPA 72, shall be made out, in triplicate, and signed by the owner's representative, indicating that they witnessed the actual test of the system.

3.6 FINAL INSPECTION

- A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.7 INSTRUCTIONS

- A. Furnish the services of a Simplex field representative who shall have specialized experience in the operation and maintenance of the systems and shall instruct the owner's personnel in the techniques involved in the operation of the systems.
- B. Formal on-site training shall be provided to the owner's representative/maintenance personnel and shall include instructions in the location, inspection, maintenance, testing and operation of all electronic components.
- C. Provide minimum of (4) hours of general instruction. Provide a signed copy of the name of the personnel giving the instructions and the personnel of the owner who were instructed.

END OF SECTION 283100

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SECTION 285500 - RF SURVEY FOR EMERGENCY RESPONDER RADIO ANTENNA/ REPEATER BDA SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. The purpose of this specification is to establish the requirements and standards for initial survey for public safety radio signal strength per NFPA and IFC
- B. Survey should be performed after the building is substantially completed, and prior to start of installation of electrical wiring.
- C. Conduct a survey using a RF Spectrum Analyzer, a calibrated, system-compatible radio or another suitable instrument with traceable certificate of calibration to analyze the RF signal strength of Emergency Responder Radio Signal into the building and determine if amplification of the signal is required. Both inbound and outbound signal strength shall be determined, measured, calculated and documented as required by code.

1.2 SURVEY CRITERIA IF REQUIRED

- A. The required Public Safety Radio Signal Level inside the Owner's facility must be determined per code, ordinance or AHJ
- B. Survey shall be performed by an FCC licensed technician holding a current GROL license. NOTIFIER have distributors that meet these requirements.

1.3 REGULATIONS

- A. Codes, regulations and standards referenced in the Section are:
 - 1. NFPA 1 – The National Fire Code (including Annex O from 2009)
 - 2. NFPA 70 – The National Electrical Code
 - 3. IFC 510- Emergency Responder Radio Coverage
 - 4. NFPA 101, Life Safety Code, the Ohio Building Code, and Local Code and Building Authority requirements.
 - 5. NFPA 72 National Fire Alarm Code
 - 6. FCC 47 CFR Private Land Mobile Radio
 - 7. 90.219 Services-Use of Signal Boosters
 - 8. ICC International Fire Code, Code and Commentary
 - 9. Local or State Promulgated Fire Code
 - 10. ADA "Americans with Disabilities Act"
 - 11. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields"
 - 12. FCC Rules Part 22, Part 90 and Part 101

13. NFPA 1221 2016 Edition
14. International Building Code 2012 / 2015 / 2018
15. UL 2524

1.4 DEFINITIONS

A. Definitions:

1. Bi-Directional Amplifier BDA: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station and in the downlink from the base station to subscriber devices for enhanced signals and improved coverage.
2. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services, or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
3. FCC: Federal Communications Commission
4. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
5. Public Safety/First Responder: Public Safety or First Responder agencies that are charged with the responsibility of responding to emergency situations. These include, but are not limited to law enforcement departments, fire departments, and emergency medical companies.
6. RSSI: Received signal strength indicator RSSI is a measurement of the power present in a received radio signal.
7. BER: Bit Error Rate is the number of bit errors per unit time
8. GROL- FCC General Radio Operators License
9. ERRCES- Emergency Responder Radio Coverage Enhancement System
10. DAS-Distributed Antenna System

1.5 EXECUTION

A. Testing Procedures

1. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the -95dBm nominal signal at 100%.
2. Spectrum Analyzer or Calibrated Handheld Radio shall be used as basis for signal measurements or other method as approved by AHJ.
3. Testing should be based on a minimum of 20 grid locations per floor OR maximum of 1600 SQ ft. areas if the floor exceeds 32,000 Sq. Ft. Also, testing should include all critical areas per NFPA. See 1.02 of this specification and NFPA 72 2013 or NFPA 1 221 2016. OR per any method determined by the AHJ, local code or ordinance.
4. A minimum signal strength of -95 dBm shall be provided throughout the coverage area for both uplink and downlink by the Local Fire Department.
 - a. RSSI measurement only

- B. Submit testing data for each level of the building.
1. An RF measurement drawing of each floor of the building which indicates relative RF field strength for each frequency band of interest must be submitted to the AHJ.
 2. The drawing should indicate clearly the areas that have passed or failed based on the above parameters.

END OF SECTION 285500

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SECTION 310500 – EXCAVATION, BACKFILL AND COMPACTION OF UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Excavation, backfill and compaction associated with utility construction including such related features as protection of adjacent utilities and structures, maintenance and protection of traffic, cutting paved surfaces, support of excavation, control of excavated materials, dewatering, piping, bedding, disposal of excavated materials, and all work related to providing excavation, backfill and compaction for all site utilities and structures in connection with water mains, sanitary sewer piping, and storm sewage system, 5'-0" beyond the exterior face of the building as shown on the Civil Drawings.
- B. Gas Line Work: Contractor shall do the trench excavation Work including all coarse aggregate or sand bedding and backfilling. The Gas Company shall install all gas piping.
 - 1. The Contractor shall verify with the Gas Company prior to bidding, which materials to use for bedding and backfilling the gas line.
- C. Related Sections include the following:
 - 1. Division 31 Section "Site Clearing".
 - 2. Division 31 Section "Sedimentation and Erosion Control Systems".
 - 3. Division 31 Section "Earthwork".
 - 4. Division 33 Section "Sanitary Sewerage Piping".
 - 5. Division 33 Section "Storm Drainage System".
 - 6. Division 33 Section "Water Mains".
- D. Unit Prices: See General Construction Bid Form for unit pricing information.
- E. Allowances: See General Construction Bid Form for material allowances.

1.3 SUBMITTALS

- A. Certificates: Submit certification attesting that the composition analysis of pipe embedment and select material stone backfill materials meet specification requirements.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing and inspection shall be performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer, specializing in soils engineering.
- B. Reference Standards:
 - 1. Pennsylvania Department of Transportation:
 - a. Regulations Governing Occupancy of Highways by Utilities (67 PA Code, Chapter 459)
 - b. Publication 408 Specifications, Pennsylvania Test Method, PTM 106 Pennsylvania Test Method, PTM 402
 - c. Publication 213, Temporary Traffic Control Facilities
 - 2. American Society for Testing and Materials (ASTM):
 - a. ASTM D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft.-lbf/ft³)
 - b. ASTM D 2922 Standard Test Method for Density of Soil and Soil - Aggregate in Place by Nuclear Methods (Shallow Depth)
- C. Compaction Testing: Compaction shall be by the testing procedure contained in ASTM D 2922 based on previously determined compaction curve data as established by ASTM D 698.

1.5 JOB CONDITIONS

- A. Excavation and Rock Removal:
 - 1. See Section 312000 "Earthwork" relative to removal of rock and classification of excavation. All requirements and classification for excavation, rock removal, earthwork, etc. specified under Section 312000 "Earthwork" shall be made a part of this Section.
- B. Compaction of Backfill:
 - 1. Excavations shall be backfilled with lifts which are individually compacted.
 - 2. The following compaction densities (based on standard Proctor Curve ASTM D 698) shall be achieved:

- a. Trench Backfill under asphalt and concrete paving (not including base course materials): 100%.
 - b. Trench Backfill within Unpaved Areas: 95%.
 - c. Exterior Side of Structures: 95%.
 - 3. Contractor shall maintain optimum moisture content of backfill materials to attain the required compaction density.
- C. Protection of Existing Utilities and Structures:
- 1. Take all precautions and utilize all facilities required to protect existing utilities and structures. In compliance with Act 181 (2006) of the General Assembly of Pennsylvania, advise each Utility at least three (3) working days in advance of intent to excavate, do demolition work and give the location of the job site. Request cooperative steps of the Utility and suggestions for procedures to avoid damage to its lines.
 - 2. Advise each person in physical control of powered equipment or explosives used in excavation or demolition work of the type and location of utility lines at the job site, the Utility assistance to expect, and procedures to follow to prevent damage.
 - 3. Immediately report to the Utility and the Architect any break, leak or other damage to the lines or protective coatings made or discovered during the work and immediately alert the occupants of premises of any emergency created or discovered.
 - 4. Allow free access to Utility personnel at all times for purposes of maintenance, repair and inspection.

PART 2 - PRODUCTS

2.1 PIPE BEDDING OR EMBEDMENT MATERIAL

- A. PennDOT No. 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications, PennDOT 2RC, or as indicated on the drawings.
- B. AASHTO No. 57 coarse aggregate, Table C, Section 703.2, Publication 408 Specifications, or as indicated on the drawings.
- C. AASHTO No. 8 coarse aggregate, Table C, Section 703.2, Publication 408 Specifications, or as indicated on the drawings.
- D. Provide as indicated on the drawings.

2.2 SLAB OR BASE MATERIAL

A. Concrete Slab or Precast Base:

1. PennDOT No. 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications or PennDOT 2RC.

2.3 BACKFILL MATERIAL FOR UTILITIES AND STORM WATER

A. Under All Concrete and Asphalt Paving:

1. PennDOT 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications, PennDOT 2RC or as indicated on the drawings.
2. AASHTO No. 57 coarse aggregate, Table C, Section 703.2, Publication 408 Specifications or as indicated on the drawings.
3. See trench bedding details and trench restoration notes on civil drawings for additional information.

B. Unpaved Areas:

1. Lawn Areas Within Road Right-of-Way: PennDOT 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications or PennDOT 2RC.

2.4 DETECTABLE WARNING TAPE

- A. Acid and alkali resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, including storm water, 6" wide, 4 mils thick, continuously inscribed with a description of the utility with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep, colored as directed by authorities having jurisdiction on the project or as directed by the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Layout utility trenchwork and establish extent of excavation by area and elevation. Designate and identify datum elevation and project engineering reference points. Set required lines, levels, and elevations.
- B. Notify Architect of unexpected subsurface conditions and discontinue work in area until notified to resume work.
- C. Maintain and protect existing utilities identified by utility users within the Work area.
- D. Verify that structure walls are braced to support surcharge forces imposed by backfilling operations.

3.2 EXISTING UTILITIES

- A. Remove abandoned utility service lines as indicated on the drawings or directed by the Architect from areas of excavation.
- B. Accurately locate and record on project record documents abandoned and active utility lines rerouted or extended.

3.3 PROTECTION OF ADJACENT WORK

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Grade excavation top perimeter to prevent surface water runoff into excavation or to adjacent properties.

3.4 MAINTENANCE AND PROTECTION OF TRAFFIC

- A. Coordinate the work to ensure the least inconvenience to traffic and maintain traffic in one or more unobstructed lanes unless closing the roadway is authorized.
- B. Maintain access to all streets and private drives.
- C. Provide and maintain signs, flashing warning lights, barricades, markers, and other protective devices as required to conform with construction operations and to keep traffic flowing with minimum restrictions.
- D. Maintain protective measures in accordance with the requirements of OSHA and other authorities having jurisdiction. The Contractor shall pay for all permits and inspections that are required for the installation.
- E. Maintenance and protection of traffic shall comply with PennDOT standards on all public streets.

3.5 CUTTING PAVED SURFACES

- A. Where installation of pipelines, structures, and appurtenances necessitate breaking a paved surface, make cuts in a neat uniform fashion forming straight lines parallel with the edge of the excavation. Cut offsets at right angles to the edge of the excavation.
- B. Protect edges of cut pavement during excavation to prevent raveling or breaking; square edges prior to pavement replacement.
- C. The requirement for neat line cuts, in other than state highways, may be waived if the final paving restoration indicates overlay beyond the width of the excavation.

- D. When unstable or unsuitable material is encountered, it shall be removed for the full width of the trench to a depth ordered by the Geotechnical Engineer and replaced with suitable material.

3.6 EXCAVATION

A. Depth of Excavation:

1. Pipelines: Excavate trenches to the depth and grade shown on the profile drawings for the invert of the pipe plus that excavation necessary for placement of pipe bedding material.
2. Where unsuitable bearing material including shattered rock due to drilling or other operations is encountered in the bottom of the excavation, discontinue excavation until the unsuitable material is observed by the Architect or the Owner's representative.
3. Where contractor, by error or intent, excavates beyond the minimum required depth, backfill the excavation to the required depth with pipe bedding/embedment or slab/base material as appropriate without any change in the Contract Price.

B. Width of Excavation:

1. Pipelines:
 - a. Excavate trenches, including laterals, to a width necessary for placement and jointing of the pipe, and for placing and compacting pipe embedment under, around and over the pipe.
 - b. Shape trench walls completely vertical from trench bottom to at least two (2) feet above the top of the pipe.
 - c. For pressure pipeline fittings, excavate trenches to a width that will permit placement of concrete thrust blocks. Provide earth surfaces for thrust blocks that are perpendicular to the direction of thrust and are free of loose or soft material.
2. Structures:
 - a. Excavate to the minimum distance necessary for placement/installation of the footings, concrete slab, walls or prefabricated structures and to permit proper backfill procedures to be performed.

C. Length of Open Trench:

1. Do not advance trenching operations more than 200' ahead of completed pipeline.

3.7 SUPPORT OF EXCAVATION

- A. Support excavations with sheeting, shoring, and bracing or in the case of pipeline construction, a "trench box" as required to comply with Federal, State, and local laws and codes.
- B. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through negligence or fault of contractor in any other manner, shall be repaired at contractor's expense.
- C. Withdraw shoring, bracing, and sheeting as backfilling proceeds unless otherwise directed by the Architect.
- D. The neglect, failure or refusal of the Architect to order the use of bracing or sheeting, or a better quality, grade, or section, or larger sizes of steel or timber, or to order sheeting, bracing, struts, or shoring to be left in place, or the giving or failure to give orders or directions as to the manner or methods of placing or driving sheetings, bracing, jacks, wales, stringers, etc., shall not in any way or to any extent relieve Contractor of any responsibility concerning the condition of excavation or of any of his obligations under the Contract, nor shall any delay, whether caused by any action or want of action on the part of Contractor, or by any act of Owner and Architect or their agents, or employees, resulting in the keeping of an excavation open longer than would otherwise have been necessary, relieve contractor from the necessity of properly and adequately protecting the excavation from caving or slipping, nor from any of their obligations under the Contract relating to injury of persons or property, nor entitle them to any claim for extra compensation.

3.8 CONTROL OF EXCAVATED MATERIAL

- A. Keep the ground surface, within a minimum of 2' of the sides of the excavation free of excavated material.
- B. Provide temporary barricades to prevent excavated material from encroaching on private property, walks, gutters, and storm drains.
- C. Maintain accessibility to all fire hydrants, valve pit covers, valve boxes, curb boxes, fire and police call boxes, and other utility controls at all times. Keep gutters clear or provide other satisfactory facilities for street drainage. Do not obstruct natural water courses. Where necessary, provide temporary channels to allow the flow of water either along or across the site of the work.
- D. In areas where excavations parallel or cross streams, ensure that no material slides, is washed, or dumped into the stream course.

3.9 DEWATERING

- A. Keep excavations dry and free of water. Dispose of precipitation and subsurface water clear of the work.

- B. Maintain pipe trenches dry until pipe has been jointed, inspected, and backfilled, and concrete work has been completed. Prevent trench water from entering pipelines under construction.
- C. Intercept and divert surface drainage away from excavations. Design surface drainage systems so that they do not cause erosion on or off the site, or cause unwanted flow of water.
- D. Comply with Federal and State requirements for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control.
 - 1. See Section 312319 for all requirements of dewatering.

3.10 PIPE LAYING

- A. Provide required pipe bedding placed in accordance with the Drawings and Specifications. A minimum bedding of 6 inches shall be provided.
- B. Shape recesses for the joints or bell of the pipe by hand. Assure that the pipe is supported on the lower quadrant for the entire length of the barrel.
- C. Lay pipe as specified in the appropriate Section of these Specifications for pipeline construction.

3.11 BACKFILLING EXCAVATIONS

- A. Pipeline Trench:
 - 1. After pipe installation and inspection, provide material to complete the pipe embedment in accordance with the Drawings and Specifications.
 - 2. Unless otherwise shown on the Drawings, the following bedding or embedment requirements using the material indicated:
 - a. Storm Sewers: PennDOT 2A coarse aggregate.
 - b. Water: PennDOT 2A coarse aggregate.
 - c. Sanitary Sewer Piping: PennDOT 2A coarse aggregate.
 - 3. The material shall be hand placed and carefully compacted with hand-operated mechanical tampers in layers of suitable thickness to provide specified compaction around and under the haunches of the pipe. Backfill and compact the remainder of the trench with specified backfill material in accordance with the Drawings and any relevant permit conditions. Employ a placement method so not to disturb or damage the utility line in the trench. Use of a Hydra-hammer or jumping-jack type compaction device is not permitted. A vibratory plate type compaction device is acceptable. Any settlement which occurs because of consolidation of the backfill during the construction period or during the

one (1) year maintenance period shall be completely corrected by contractor at his expense.

4. Install trench plugs as indicated on the drawings.
5. Provide warning tape approximately 24 inches below finished grades and above all piping.

B. Lift Thickness Limitations:

1. Lift thicknesses shall be limited to 4 inches for pipe embedment, and 8 inches maximum for pipeline trenches within paved areas and non-paved areas and for structure excavations. Lift thicknesses shall also comply with requirements imposed by any State Highway Occupancy Permit. In no case shall maximum lift thickness placed exceed the maximum limits specified by the manufacturer's recommendations for the compaction equipment to be utilized. Compaction equipment shall not be used over the pipe until sufficient backfill has been placed to insure that such equipment will not damage or disturb the pipe.
2. Lift thickness limitations specified for State highways, shoulders, or embankments govern over the compaction equipment manufacturer's recommendations.

C. Unsuitable Backfill Material:

1. Where the Geotechnical Consultant or Architect determines backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with suitable backfill material.

3.12 FIELD QUALITY CONTROL

- A. The Owner shall provide and pay for testing and inspection during trenchwork operations.
- B. Quality Control Testing During Construction: The testing laboratory shall inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
 1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method), as applicable.
 - a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.

- b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.
- 2. Perform one test at each structure and one test for each 150 lineal feet of pipe or fractions thereof per foot of backfill.
- 3. If in opinion of Architect, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained.

3.13 DISPOSAL OF EXCAVATED MATERIAL

- A. Excavated material remaining after completion of backfilling shall remain the property of contractor, removed from the construction area, and disposed of legally, off-site. However in the event the excavated material can be used in filling and rough grading on the site as determined by the Architect, it shall remain on the site and be used for grading and filling.

3.14 CLEANUP

- A. Upon completion of trenchwork operations, clean areas within contract limits, remove tools and equipment. Provide site clear, clean, free of debris, and suitable for site work operations.

END OF SECTION 310500

SECTION 311100 – SEDIMENTATION AND EROSION CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Extent of sedimentation and erosion control systems work is indicated on the Civil Drawings and by requirements of this Section and all regulatory bodies having jurisdiction on this work.
 - 1. See Civil Drawings for Erosion Control Notes and details for additional information related to sedimentation and erosion control measures.
 - 2. Implement and maintain the Erosion and Sedimentation Control Plan prepared for this project.
- B. Contractor shall carry out the construction operations in a manner that soil erosion and resulting turbid storm water runoff and sedimentation are minimized and to limit downstream property damage.
- C. The Owner has obtained and paid for an NPDES Permit for the Project. The Contractor shall apply for and obtain an approval of the NPDES Permit Transferee/Co-Permittee Application to be added as a Co-Permittee. A copy of the Application Form has been attached at the end of Section 311100 for Contractor's use. The Contractor shall keep all inspection reports on file and maintain all record keeping requirements to satisfy the permit requirements. The Contractor shall be responsible for and pay all fines, fees, and charges for the Erosion and Sedimentation Control Plan. The Contractor shall also submit a Discharge Monitoring Report at the frequency required by the County Conservation District transfer.
 - 1. At completion of the project, the Contractor shall pay for and obtain the termination of the NPDES Permit after complying with the correction of all deficiencies.
- D. The Contractor shall be responsible to maintain a clean jobsite and prevent spills or any kind. Contractor shall have a pollution prevention plan in place.
- E. Related Sections include the following:
 - 1. Division 31 Section "Excavation, Backfill and Compaction of Utilities".

2. Division 31 Section “Site Clearing”.
3. Division 31 Section “Earthwork”.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of sedimentation and erosion control system's products of types, materials, and sized required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with sedimentation and erosion control work similar to that required for project.
- C. Codes and Standards: The most current version of the publications listed below form a part of this specification to the extent referenced.
 1. Pennsylvania Department of Environmental Protection Office of Water Management: Erosion and Sediment Pollution Control Program Manual.
 2. Pennsylvania Department of Transportation Publication 408 Specification.
 3. Pennsylvania Code, Title 25 Environmental Protection, Chapter 102 Erosion and Sediment Control.
- D. Environmental Compliance: Comply with applicable portions of the respective County Conservation District regulations pertaining to sedimentation and erosion control systems and pollution prevention.
- E. Preinstallation Conference: Immediately after the “Notice to Proceed” has been issued, the contractor shall conduct a preconstruction meeting to review the sedimentation and erosion control system procedures and implement the system. Notify Owner and Conversation District as required by approved plans.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for all sedimentation and erosion control materials and products.
- B. Permits: Contractor shall apply for all permits required for this work from all agencies and authorities having jurisdiction on this project and work. Contractor shall comply with and maintain all permits until the date of Substantial Completion after which the Contractor shall comply with all close-out requirements and activities required by all regulatory bodies.
 1. Cost of the permits shall be paid for by the Contractor.

1.5 PROJECT/SITE CONDITIONS

A. Associated work activities include but are not limited to the following items:

1. Temporary and permanent measures will have to be undertaken before, during and after construction to control sediment from being carried onto adjoining properties and into swales or watercourses as a result of stormwater runoff.
2. The use of temporary control devices as shown on the Drawings and as described in these Specifications are for providing the trapping of sediment resulting from construction activities and to reduce the velocities of the temporary stormwater courses to minimize erosion.
3. The erosion and sediment control devices shall be inspected weekly and at every storm event and maintained throughout the life of this project. These shall include, but are not limited to, silt barrier fences, temporary sediment basins and traps, rock energy dissipaters, inlet protection, temporary seeding, etc. as shown on the Drawings or other measures that are required for the construction of this project.
4. Upon completion of the project and after the temporary erosion control devices have served their purpose, these temporary devices shall be removed from the project by the Contractor.
5. Contractor shall keep all public thoroughfares and all on-site paved areas free of mud and similar debris from construction activities throughout the entire construction period.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Silt Barrier Fences:

1. PennDOT Publication 408 Specifications, Section 865.
2. As shown on the drawings.

B. Geotextile for stabilized construction entrances shall be in accordance with PennDOT Publication 408 Specifications, Section 735, Class 4, Type B.

C. Inlet Filters: As shown on drawings:

D. Silt Fences, Compost Filter Sock, Temporary Seeding, Rock Filters, Sedimentation Basins with Appurtenances, Inlet Protection, Construction Entrances, Sedimentation Controls, Erosion Control Blankets, Emergency Spillway, etc.:

1. As shown on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a minimum 7-day notice to County Conservation District prior to beginning construction activities.
- B. Erection and maintenance of a silt barrier fence as shown.
- C. Construction and maintenance of sediment traps, basins, and all associated appurtenances as shown on the plans.
- D. Installation and maintenance of Inlet Filtering Devices as shown on the plans.
- E. All sediment spilled, dropped, washed, or tracked onto the existing roads or streets must be removed immediately. The contractor shall provide a mechanical street sweeping machine on a regular basis, manual sweeping, or maintenance as directed by the Owner to remove sediment from surfaces outside the work area.
 - 1. Sediment shall be removed and disposed of when directed or as indicated on the drawings or within regulations. Sediment shall be disposed of in a manner acceptable to the Township.
- F. Performing temporary seeding and mulching of disturbed areas until final grading and stabilization can be accomplished.
- G. The dewatering or pumping out of excavated areas directly into existing storm ditches or natural channels which cause silt deposition, turbidity and/or possible erosion of banks is prohibited. Contractor must make use of sediment traps, filters, or other methods acceptable to the Architect.
- H. Provide geotextile fabric under rocks where shown. Place rocks carefully in the fabric to produce an even distribution with a minimum of voids and without tearing the geotextile fabric. Arrange rocks in full thickness indicated in one operation in a manner to prevent segregation and re-arranged as necessary to insure uniform distribution.
- I. Remove all sedimentation and erosion control systems when no longer required as determined by the Architect and only when approved by the Conservation District.

3.2 FIELD MODIFICATIONS

- A. Owner reserves the right to add to, delete, or modify any or all sediment control measures described herein as required to establish proper soil erosion and sedimentation control and comply with all agencies and regulatory bodies having jurisdiction on this work and project.

END OF SECTION 311100

SECTION 312000 – EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Conditions and Division 1 Specification Sections, apply to this Section.
 - 1. Soil Management for arsenic remediation is documented on the Erosion and Sediment Control Plans.
 - 2. Rock Removal Areas exhibit plans by T&M Associates Drawing RC1 Sheets 1 through 3. Note these drawings represent T&M's opinion of areas where dense weathered rock will be encountered based on the Geotech Report Part 3.26 of this Section. The accuracy or completeness of the Rock Removal Areas exhibit plan is not guaranteed by the Owner or the Architect. This information is provided to the Contractor for information purposes only.

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and plantings.
 - 2. Excavation and backfilling for buildings and structures.
 - 3. Drainage course for building floor slabs-on-grade.
 - 4. Subbase course for asphalt pavement and site concrete.
 - 5. All grading and filling for the project.
 - 6. Imported structural fill.
 - 7. Imported top soil to supplement existing top soil deficiencies.
 - 8. Removal and replacement of unsuitable materials.
 - 9. Site demolition and clearing.
 - 10. Shoring and Bracing.
 - 11. Disposal of excess materials

- B. Excavating and Backfilling for Mechanical/Electrical Work: Excavation and backfill required in conjunction with underground mechanical and electrical utilities and buried mechanical and electrical appurtenances within the building will be provided by the respective contractors installing the materials as specified in the specifications for Plumbing Construction, HVAC Construction, and Electrical Construction.
- C. Related Sections include the following:
1. Division 31 Section "Excavation, Backfill, and Compaction of Utilities" for all site utility excavation and backfill including storm water drainage system.
 2. Division 31 Section "Site Clearing and Demolition" for site clearing work.
 3. Division 31 Section "Trenching" for trenching operations.
 4. Division 32 Section "Turf and Grasses" and "Synthetic Turf" for site seeding and lawns.
 5. Division 32 Section "Plants" for site landscaping and plantings
 6. "Summary of Work", specifically relating to the requirement for arsenic soil remediation via soil replacement/capping.
- D. Unit Prices: See proposal pages for unit prices.
- E. Allowances: See proposal pages for material allowances.

1.3 DEFINITIONS

- A. Backfill: Soil materials or imported structural fill materials used to fill an excavation.
- B. Base Course: Layer placed between the subbase course and asphalt paving.
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying a pipe.
- D. Offsite Borrow: Satisfactory soil fill and select structural fill imported from off- site for use as backfill or fill.
- E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations.

1. Additional Excavation: Excavation below subgrade elevations as directed by the Architect or the Geotechnical Consultant.
 - a. When excavation has reached required subgrade elevations, notify Geotechnical Consultant, who will make an inspection of conditions. If Geotechnical Consultant determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Geotechnical Consultant. The Contract Sum will be adjusted in accordance with the unit prices set forth by the contractor in the Form of Proposal.
2. Bulk Excavation: Excavations more than 10 feet in width and pits more than 30 feet in either length or width.
3. Unauthorized Excavation: Excavation below the subgrade elevations or beyond indicated dimensions without written direction by the Architect or Geotechnical Consultant. Unauthorized excavation, as well as remedial work directed by the Architect or Geotechnical Consultant, shall be without additional compensation.
- G. Fill: Soil materials or select structural fill materials used to raise existing grades.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical, appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer between the subgrade and a drainage course of a concrete pavement or walk.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- K. Unsuitable Material: Soils, debris, waste, frozen materials, and other deleterious materials to be determined by the Owner's Geotechnical Consultant to be unsuitable to attain required bearing capacity.
- L. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
- B. Geotechnical Consultant: The Owner shall provide and pay for the services of a Geotechnical Consultant who will have the responsibility of determining what subgrade is acceptable or unacceptable and must be removed by the Contractor.

The fill and or structural soil fill or select structural fill shall be installed and compacted under the direction and observation of the Geotechnical Consultant. See Form of Proposal for unit prices and allowances on this work. The Geotechnical Consultant will also document quantities of all materials on a daily basis. The Geotechnical Consultant will also monitor other earthwork that the Owner determines.

- C. Pre-Excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.5 PROJECT CONDITIONS

- A. Site Information: Data in subsurface investigation reports was used for the basis of the design and are available to the Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. The Owner will not be responsible for interpretations or conclusions drawn from this data by the Contractor.
1. Additional test borings and other exploratory operations may be performed by the Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
- B. Site Verification: Verify layout information shown on the drawings, in relation to the property survey and existing benchmarks, before proceeding to lay out the work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.
- C. Prior to the start of any earth moving activities and site work, the Contractor shall be fully responsible to verify all site grades, contours, etc. and shall take all field measurements of existing conditions, benchmarks, property lines, and topography to determine if there are any omissions or inconsistencies in the Contract Documents.
- D. In the event that inconsistencies, errors or discrepancies are discovered, then the Contractor shall immediately notify the Architect in writing. If the Contractor commences earth moving activities or site work, it will be considered an acceptance by the Contractor of the Contract Documents and site grades and conditions. Claims for additional compensation or extension of time from the Contractor for failing to comply with the specified verification procedures will not be considered.
- E. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations. The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning earthwork and sitework, investigate and verify the

existence and location of underground utilities and other construction.

1. Prior to excavation the Contractor shall comply with all regulations on excavation as set forth in the Contract Documents General Conditions of the Contract and with all regulatory bodies having jurisdiction on this project.
 - a. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. The Owner and Architect shall be notified immediately, should active utilities not indicated on the drawings be encountered. Such utilities shall be adequately protected, supported or relocated as directed by the Architect
 - b. Abandoned utilities not indicated on the drawings which are encountered in excavating within the limits of the buildings shall be removed to a point at least three (3) feet outside of the building walls, or as required by local regulations. Except as otherwise specified above, abandoned utilities may remain in place, provided they do not interfere with the new construction, in which case they shall be removed to the full extent of such interference. Remaining lines shall be suitably plugged or capped. The Architect shall make the final determination on which abandoned utility lines can be abandoned in-place.
 - c. A. Warning Tape: Acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6" wide and 4 mils thick, continuously inscribed with a description of the utility; color as follows:
 - a. Red: Electric.
 - b. Yellow: Gas, oil, steam, and dangerous materials.
 - c. Orange: Telephone and other communications.
 - d. Blue: Water systems.
 - e. Green: Sewer systems.

F. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

1. Operate warning lights as recommended by authorities having jurisdiction.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
3. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

1.6 SUBSURFACE INFORMATION

- A. Any available data concerning subsurface materials or conditions which is based upon soundings, test pits or test borings, has been obtained by the Owner to assist the Architect in designing this project. Its accuracy or completeness is not guaranteed by the Owner or the Architect and in no event is it to be considered as part of the contract Drawings or Specifications. This information is provided the Contractors for information purposes only.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Subbase Material: Shall meet the requirements of PennDOT No. 2A coarse aggregate and Select Granular Material 2RC.
- B. Drainage Fill: Drainage fill shall be AASHTO Size #57 stone in accordance with the gradation set forth in PennDOT 408 Section 703. No modified base is permitted.
1. Use under building floor slabs-on-grade.
- C. Fill Materials: Fill materials shall be classified as follows:
1. Structural Soil Fill: Fill supporting slabs, pavements, and foundations is considered herein to be structural fill. Structural fill shall be placed on an approved, proof rolled, nonyielding, level subgrade, in lifts not exceeding 8 inches (loose thickness), unless otherwise directed by the Geotechnical Engineer. Structural fill shall be maintained nominally at Optimum Moisture Content (ASTM D-698) and uniformly compacted to the percentages of Maximum Dry Density (ASTM D-698) provided in Table III - Compaction Criteria provided in the April 26, 2023 Geotechnical Report prepared by David Blackmore and Associates. Suitable structural fill shall consist of clean soils without deleterious inclusions. On-site soils identified as Stratum I, and II are acceptable for use as structural fill if given the opportunity to dry and the soils are maintained nominally at Optimum Moisture Content. Samples retrieved from the upper 5 feet of the subgrade indicated moisture contents ranging from 11.9 to 21.9 percent. The optimum moisture content for compaction of site soils is estimated to range between 12 and 15 percent. Therefore, some of these soils may require aeration and drying prior to re-use as structural fill.

For Structural Soil Fill Areas beneath parking lot interior landscape islands:

The following details are to ensure adequate soil media for plant growth where Structural Soil Fill is required.

- a. Gravel shall consist of crushed stone approximately one inch in diameter.

- b. Soils shall consist of loam to clay loam, containing at least 20% clay content.
 - c. Ratio of stone to soil shall be 80% stone to 20% soil by dry weight.
 - 1. Borrow Fill: Borrow fill shall be clean well-graded soils with good strength characteristics with a maximum particle size of 3 inches and containing not more than 20% silt/clay (by weight). Samples of on-site or borrow sources of fill shall be submitted to the Geotechnical Engineer for testing at least 1 week before use on site. A minimum of 65 lbs. or two (2) five-gallon buckets is required for testing.
 - 2. Structural Aggregate Fill (for ALTERNATE No. 2): structural fill 2A stone, including spreading and compacting to 98% of its maximum dry density as established by ASTM D 698 in 8" lifts.
- D. Top Soil: All stockpiled top soil shall be used for all lawn areas. In the event there is a shortage of stockpiled top soil the Contractor shall import top soil at his expense.
- 1. Imported top soil shall be natural, fertile, friable loam or sandy loam as classified by the U. S. Department of Agriculture Soil Classification system, and typical of the cultivated topsoils of locality. The soil shall contain not less than 1% or more than 8% by weight, of decayed organic matter (humus), as determined by ASTM F 1647. The topsoil shall be taken from a well drained, arable site, free from sub-soil, large stones, earth clods, sticks, stumps, clay lumps, roots, or other objectionable, extraneous matter of debris. Topsoil shall also be free of Quackgrass rhizomes, Agropyron Repens, and the nut-like tubers of Nutgrass, Cyperus Esculentus, and all other primary noxious weeds. Topsoil shall not have a pH of less than 6.0 or greater than 7.5. Topsoil shall not be delivered or used for planting while in a frozen or muddy condition. The top soil shall be approved by the Architect prior to use and after review of a test report.
 - a. Topsoil shall conform to the following particle size distribution, as determined by pipette method in compliance with ASTM F 1632:

Sand	22. to 2 mm)	40% to 60%
Silt	23. to 0.05 mm)	30% to 40%
Clay	(<0.002 mm)	10% to 20%
Gravel	(>2.0 mm)	<15%

- 2. Maximum size shall be 1/2 inches largest diameter.
 - a. If organic amendments are needed to obtain the specified organic matter content of the topsoil, the organic matter source may be a peat or compost material. The peat shall be Canadian sphagnum peat having an ash content not exceeding 15%, as determined by

ASTM D 2974. Composts may be used, provided that the material has been composted in an in-vessel system and has an ash content not exceeding 40%, and is screened to 1/4 inch.

3. In the event there is a surplus of stockpiled top soil then the Contractor shall deposit and spread the top soil as directed by the Architect. Surplus top soil shall not be removed from the site.
4. Existing topsoil slated for reuse shall be tested by an accredited soil testing lab or agency to determine pH levels and nutrient availability. Topsoil shall be amended as required based on results of soil test. Topsoil testing and amendments shall be at the contractor's expense.

PART 3 - EXECUTION

3.1 SITE DEMOLITION AND CLEARING

- A. Remove all improvements, abandoned structures, paved surfaces, utility lines and other items shown on the drawings and indicated to be removed or required to be removed in order to install new work as shown.
- B. Remove all objectionable material, rubbish and junk within the Project limits.
- C. Clear and grub the site of small caliper vegetative matter and roots. Hand grub under drip line of trees designated to remain.
- D. Remove trees, including stumps and root systems, unless specifically indicated to remain.
- E. Dispose of removed material off site in accordance with requirements of this specification. Burning of waste material on the site is not permitted.

3.2 STRIPPING TOP SOIL

- A. Before starting rough grading, top soil shall be removed to its full depths and hauled from the site for use in future finish grading. Remove heavy growths of grass before stripping topsoil.

3.3 ROUGH GRADING

- A. All areas within and outside the building shall be rough graded to subgrade elevations, which shall be finished grades less thicknesses of finish materials as shown on the Drawings. Only satisfactory fill as previously specified shall be used.

- B. If fill for construction of embankments is to be placed on existing slopes steeper than 4:1, benches shall be cut into the slope so that fill can be placed in level lifts.

Benches shall be cut wide enough to allow passage of compaction equipment.

- C. Fill shall be placed and compacted in accordance with requirements of this section.
- D. At the end of each working day the fill surfaces shall be sealed by rolling to promote surface runoff and graded to prevent ponding of water.

3.4 EXCAVATION

A. General:

1. The Contractor shall complete the excavation in phases as indicated on the drawings and in Section 011000 "Summary of Work".
2. In the event that there is excess excavated material remaining after completion of backfilling shall remain the property of Contractor, removed from the construction area, and disposed of legally, off-site. However in the event the excavated material can be used in filling and rough grading on the site as determined by the Architect, it shall remain on the site and be used for grading and filling.
3. When excavation has reached required subgrade elevations, notify the Geotechnical Consultant, who will make an inspection of conditions. If the Geotechnical Consultant determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as to the extent directed by the Geotechnical Consultant.
4. All footings and slabs shall be placed on suitable native soil or select structural fill tested and prepared in accordance with the project specifications. No footings or slabs shall be placed on existing fill material. Fill material shall be removed and replaced per the project specifications.
5. Erect and maintain barricades, fences, warning lights and other protection required to comply with all applicable regulations for safety of all persons at excavations
6. Excavation to full depth is not to be done when rain or freezing conditions are imminent. All excavated bearing surfaces shall be protected from frost. Where bearing surfaces are damaged by water, mud, or otherwise disturbed, all loose mud or other materials shall be removed and the surface regraded. Where the foundation excavation has been carried below plan grade due to errors in excavation, freezing, removal of mud or other loose materials or overshot or pitted rock surface, the foundation bearing surface shall be restored to plan grade

with the same strength concrete as that specified for the footing above it at no additional cost to the Owner.

When cutting of paved surfaces is required, the surface shall be machine cut in a neat, uniform manner. No paving shall be broken except that which has been previously cut. Edges of the cut pavement shall be protected during excavation and construction. Any edges which become broken shall be squared prior to pavement replacement

7. Hand excavation shall be done in any circumstance where machine excavation could damage existing or new structures or other underground improvements. Exploratory pits shall be hand dug to locate existing underground lines at connection points or points of crossing.
- B. Excavation: Removal of material encountered above subgrade elevations. All excavation within the project limits is considered unclassified in the base bid.
1. Additional Excavation: Excavation below subgrade elevations as directed by the Engineer. Additional excavation and replacement material for stabilization of yielding or otherwise unacceptable materials may be authorized by the Engineer. Subgrade stabilization shall be made by undercutting below the proposed subgrade excavation elevation, placing geotextile fabric and backfilling with AASHTO #1 stone in 6" compacted lifts to the design subgrade elevation. Payment for additional excavation will be made on a per unit basis as listed in the Bid Form. The contractor shall include in their base bid excavation below subgrade in amounts as identified in the contract documents and on the Bid Form.
 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation
- C. Storage of material or regular parking of vehicles which contain highly flammable or explosive cargoes are prohibited. Storage of flammable fuels or fueling of vehicles is also prohibited.
- D. Excavation is UNCLASSIFIED in base bid for the related work regardless of the character of surface and subsurface conditions encountered, including, but not limited to, rock, soil materials, concrete, concrete subbase, underground structures and obstructions. No additional payment shall be made for these materials. For excavation Work that is unclassified, Contractor bears the risk of encountering concealed or unknown conditions and may not seek or obtain an equitable adjustment of his Contract Sum
- E. Excavation Classifications: The following classifications of excavation will be made when rock is encountered:

1. Earth Excavation includes excavation of pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; unauthorized excavation; and all earth and other materials encountered that are not classified as rock under subparagraphs below. The Contractor shall not receive any increase in the Contract Time or the Contract Price for any earth excavation.
2. Rock Excavation Types: Rock excavation includes bulk and trench rock excavation.
 - a. Bulk Rock Excavation: Bulk rock excavation includes removal and disposal of materials and obstructions, except boulders, which are encountered and cannot be removed with heavy-duty excavating equipment without drilling, jack hammering or ripping. Excavation equipment equal to Caterpillar Model No. D-8 or D-9 or equivalent track-mounted loader, rated at not less than 84,850 pounds operating weight, 310 HP rated power and developing minimum of 50,070-pound bucket breakout force (measured in accordance with SAE J732). Excavation which can be accomplished with this equipment or equivalent shall be considered as Earth Excavation. Comply with any of the following methods for removal of rock. Method must be approved by the Geotechnical Engineer prior to commencing removal:
 - 1) Ripping: Rock excavation by ripping methods shall mean removal of rock type materials using tractors equipped with rock ripping mechanism such as No. D-8 and No. D-9 Ripper Tractors by Caterpillar Company. Rock ripping methods shall be attempted for all bulk rock excavation and shallow (4'-0"±) trench rock excavation, as it is encountered at the site; unless waived by the Geotechnical Engineer. Existing site rock which cannot be ripped with ripper tractors, and this fact is established after trial ripping, shall be excavated by rock excavation methods employing ram hammering and drilling. Intermittent ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
 - 2) Hand Method: Rock excavation by hand method shall mean removal of rock type materials by a worker using pneumatic vibrating chippers when other rock removal methods are ruled out as too dangerous to existing building and its stability.
 - 3) Ram Hammer: Rock excavation by ram hammer method shall mean removal of rock type materials using boom mounted pneumatic, impact hammer equipment, when other rock removal methods are ruled out as too

dangerous to existing building and its stability.

- 4) Boulders: Boulder excavation shall mean removal of free floating rock by excavation equipment at least equal to Caterpillar Model No. 973 or No. 320 track mounted equipment. Boulders which cannot be removed with the above equipment shall be removed and compensated for by ripping, hand method or ram-hammer. Boulders encountered shall be set aside for measurement, then removed from the site, including those not qualified as rock. Large boulders shall be split into smaller units as required for disposal at no additional cost.

b. Trench Rock Excavation:

- 1) Rock excavation for footings trenches and pits includes removal and disposal of materials and obstructions encountered that cannot be excavated with a 1.0 cubic yard (SAE heaped) capacity, Type T, 36 inch side bucket on a track-mounted power excavator, equivalent to Caterpillar Model No.325, and rated at not less than 204 HP flywheel and 64460 pound weight with a short stick.
- 2) Trenches in excess of 10 feet in width and pits in excess of 30 feet in either length or width are classified as bulk rock excavation.
- 3) Ripping hand method, ram hammer, and boulder rock removal methods may be used for trench rock removal. Reference Bulk Rock Excavation for description and definition of these methods. Intermittent ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

- F. Rock Excavation: Blasting for rock excavation may be performed upon consultation with the Owner's Representative, Architect and Geotechnical Engineer. Blasting, if required and permitted, shall be performed prior to footing installation and building construction so as not to disturb freshly poured concrete.

1. Blasting shall be performed by a similar reputable, licensed blasting contractor who is experienced with blasting in a similar geology.
2. The blasting contractor shall meet with the Owner's Representative and Geotechnical Engineer to discuss the blasting operation including safety, acceptable vibration levels, and precautions to prevent damage to nearby structures.
3. Prior to each blast, the contractor shall submit a detailed blast plan to the Owner's Representative and Geotechnical Engineer for review. The blast

plan shall include the following:

- a. Blast location, type of shot, type of material, and measured distance to nearest structure.
 - b. Number of holes, hole diameter, drill angle, depth, subdrilling, burden, spacing, and stemming.
 - c. Method of firing, surface delay periods, and downhole delay periods.
 - d. Types of explosives, total amount of explosives, size of primers, and primer locations.
 - e. Maximum Lbs/Delay, anticipated vibration level, and scaled distance including calculations.
 - f. Provide drawing of pattern, initiator hookup, hole firing times and cross section of blasthole(s) showing explosive loads and primer locations, depth, subdrill, stemming, etc.
 - g. Include manufacturer's data sheets for all products.
4. Upon approval of the blast plan and prior to blast initiation, the contractor shall install seismographs as appropriate to document vibration and airblast levels. Copies of the seismograph records shall be kept on-site.
 5. Contractor shall provide Pre and Post Blast photographs and surveys (as appropriate) of all buildings and structures on properties adjacent to the blasting operation including adjacent properties located across a public or private roadway from the blasting operation. Owner shall not be responsible for damage to nearby structures as a result of blasting operations. Contractor shall repair or replace in kind any damage as a result of blasting operations and shall be responsible for required repair or replacement for damage to buildings and structures on adjacent properties that contractor failed to full document with photographs and surveys as required.
- G. Storage of material or regular parking of vehicles which contain highly flammable or explosive cargoes are prohibited. Storage of flammable fuels or fueling of vehicles is also prohibited.
 - H. Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by the Construction Manager. Such excavation will be paid on the basis of conditions of the Contract relative to changes in work. If the Contractor proceeds with excavation prior to such cross-sectioning and classification, such excavation shall be conclusively deemed to be earth excavation.
 - I. Rock payment lines are limited to the following:

1. Two feet outside of concrete work for which forms are required, except footings.
 2. One foot outside perimeter of footings and twenty-four (24) inches below bottom (unless shown to rest on rock).
 3. In pipe trenches, 6 inches below invert elevation of pipe and 2 feet wider than inside diameter of pipe, but not less than 3 feet minimum trench width.
 4. Outside dimensions of concrete work where no forms are required.
 5. Under slabs on grade, 6 inches below bottom of concrete slab.
 6. Boulders which can be removed with specified equipment but extend beyond limits of responsibility and/or rock payment lines shall be considered within rock payment lines.
- J. When a question arises concerning classification of material to be excavated, Geotechnical Engineer shall be notified and their decision shall be final. No extra payment will be allowed unless a formal construction change directive or a change order is prepared and issued by the Project Manager or Owner's Representative.
- K. Contractor shall keep a running account of all rock excavation completed. A plan shall be kept noting location, quantity, type of excavation and date of removal for all rock excavation, and each quantity shall be initialed by Geotechnical Engineer or his official field representative directly on this plan signifying agreement to its removal. When all excavation work is completed, this rock excavation report shall be submitted to the Geotechnical Engineer and Owner's Representative to serve as a permanent record of rock excavation work completed.

3.5 STABILITY OF EXCAVATIONS

- A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- C. Shore and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.
1. Comply with all laws and regulations of the Federal Occupational Safety and Health Act of 1970 (OSHA), latest edition, as amended.
 2. The Contractor shall provide and maintain sheathing, shoring and bracing as necessary to protect workmen and work of this project and

existing structures. Restoration of damaged areas to original condition is the Contractor's responsibility. The Contractor shall submit his plan for sheeting, shoring and bracing for approval before commencing work.

3. It is also the Contractor's responsibility to remove temporary sheathing, shoring, bracing and protection when no longer required by adjacent conditions and completion of foundation construction or backfill and rough grading.

3.6 DEWATERING

- A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area. Prevent surface water from entering the building.
 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of soil and changes detrimental to stability of subgrades. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.
 3. Whenever possible, avoid allowing foundation excavations to remain open for extended periods.
 4. The Contractor shall pump out, or otherwise remove, any water which may be found in the excavation, and shall provide drainage ditches, underdrains, flumes, well points, and pumping equipment, suction and discharge lines, as necessary to keep the excavation entirely clear of water while the foundations are being built or other operations are being performed requiring a dry condition.

3.7 EXCAVATION FOR STRUCTURES

- A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
- B. Foundations: Foundations shall bear on the undisturbed dense zones of Stratum I, Stratum II, Stratum III, or on structural fill as defined in the Geotechnical Report. Soft conditions encountered during foundation construction shall be excavated and replaced with structural fill. Foundations shall be designed for a maximum soil bearing capacity of 4 KSF on the dense zones of Stratum I, Stratum II, Stratum III, or structural fill. Foundations shall not be placed intermittently on soils and boulders. Small boulders encountered within or directly beneath the footing bearing surface

shall be removed and replaced with structural fill. Larger boulders shall either be fully or partially removed and replaced with structural fill. Trench excavation through areas containing boulders may require substantial over-excavation to facilitate boulder removal. Partial removal can be completed by splitting or hammering to a minimum of 12" below the footing bottom elevation. Should the foundation excavation encounter hard bedrock, the foundation is to be undercut a minimum of 12 inches. The undercut area is to be backfilled with a structural fill or a low strength flowable fill (max 500 psi) "cushioning" layer to limit the potential for differential foundation settlement and the development of stress concentrations caused by a rock protrusion.

- C. Slab on Grade: Prior to the placement of fill the exposed slab subgrade areas shall be proof rolled with a heavy smooth drum roller (minimum 15-ton static weight) to detect the presence of loose or soft zones. This proof rolling operation shall be performed in the proposed fill areas under the supervision of the Geotechnical Engineer. Proof rolling of the subgrade shall also be performed in the cut areas when the required grades have been achieved and immediately prior to pouring the floor slab. Loose or soft zones detected during the proof rolling operation shall be repaired to the satisfaction of the Geotechnical Engineer. All slab subgrade areas shall be evaluated by the Geotechnical Engineer prior to pouring the slab so that repairs can be completed. A smooth drum roller shall be made available to seal the subgrade in the event of predicted precipitation.
- D. Excavation for Underground Tanks, Basins and Mechanical or Electrical Structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services and other construction and for inspection. Do not disturb bottom of excavations intended for bearing surface.

3.8 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Pavement and sidewalk areas shall be prepared in a manner similar to the slab on grade areas. A minimum of 8 inches of crushed aggregate base shall be used beneath exterior pavements due to the frost heave potential of the subgrade soils. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades. Unless noted otherwise, maintain subgrade with same slope and pitch as indicated for finish surface.

3.9 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated slopes, lines, depths, and invert elevations.
 - 1. Beyond building perimeter, excavate trenches for water lines to allow installation of top of pipe below frost line or to minimum depth indicated elsewhere herein or on the Contract Drawings.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300

mm) higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: A minimum of twelve inches (12") each side of pipe or conduit, or as otherwise indicated.
- C. Trench Bottoms: Excavate and shape trench as required to place bedding material and to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove large stones and sharp objects to avoid point loading.
1. Remove unstable, soft and unsuitable materials at or below the bottom of the trench upon which bedding material is to be laid.
 2. Where encountering rock or another unyielding bearing surface, carry trench excavation six inches (6") below outside surface of pipe to receive bedding course.
 3. Refer to Article, "Utility Trench Backfill" for bedding and backfill requirements.

3.10 APPROVAL OF SUBGRADE

- A. Notify Geotechnical Engineer when excavations have reached required subgrade. Provide minimum 24 hours of notice of completion time to allow for scheduled inspection.

- B. Proof-roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction. Do not proof roll wet or saturated subgrades, or subgrades occurring within two to three feet of the water table. Perform proof-rolling with a Smooth drum roller with a minimum static weight of 15 tons or loaded tandem-axle dump truck as directed and observed by the Geotechnical Engineer. The proof rolling shall be performed in the presence of the Geotechnical Engineer. The proof rolling operation shall cover the entire width and length of the proposed panel area.
- C. Do not backfill trenches until tests and inspections have been made and the Geotechnical Engineer/Owner has been informed in writing of the test results and authorizes proceeding with the backfill. Do not damage or displace pipe systems.
- D. When Geotechnical Engineer determines that unforeseen unsatisfactory soil is present at and below subgrade, continue excavation and replace with compacted backfill or fill material as directed.
 - 1. Unforeseen additional excavation and replacement material will be paid according to the contract provisions for changes in work. No such payment will be made however, if the work is not first authorized by the Geotechnical Engineer and Owner's Representative, or if the subgrade material became saturated and soft as a result of the Contractor's failure to properly protect the excavation or properly divert surface runoff away from excavations.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Geotechnical Engineer at the Contractor's expense.
- F. No stone aggregate base course or subbase course shall be placed until the subgrade of the entire section or portion of the project under preparation is approved for line, grade and stability.
- G. No topsoil is to be placed until the subgrade of an entire sub-area or portion of project under preparation is brought to an even plane and uniform depth consistent with the proposed finish grade as required by the drawings, and reviewed by the Geotechnical Engineer.

3.11 UNAUTHORIZED EXCAVATION

- A. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Geotechnical Engineer. Unauthorized excavation as well as remedial work directed by the Geotechnical Engineer shall be at the Contractor's expense.
- B. Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation or concrete foundation or footing to excavation bottom, without altering required top elevation. Controlled low-strength material may be used to bring elevations to proper position when acceptable to the Geotechnical Engineer.

- 1. Elsewhere, backfill and compact unauthorized excavations as specified for

authorized excavations of the same classification, unless otherwise directed by the Geotechnical Engineer. Fill unauthorized excavations under other construction directed by the Geotechnical Engineer.

- C. Where indicated widths of utility trenches are exceeded, provide stronger pipe, or special installation procedures, as required by the Owner's Representative.

3.12 ADDITIONAL EXCAVATION

- A. When excavation has reached required subgrade elevations, notify the Geotechnical Engineer who will make an observation of conditions and render recommendations.
 - 1. If unsuitable or excessively fractured bearing materials are encountered at required subgrade elevations, carry excavations to the level decided by the Geotechnical Engineer and replace excavated material as authorized by the Geotechnical Engineer.
 - 2. Removal of unsuitable material and its replacement as authorized will be paid on basis of contract conditions relative to changes in work.

3.13 STORAGE OF SOIL MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials.
 - 1. Stockpile soil materials without intermixing.
 - 2. Place, grade and shape stockpiles to drain surface water.
 - 3. Provide protection to prevent wind-blown dust, and accumulation of excessive moisture that may preclude use of material as intended for use on the project.
 - 4. Stockpile soil materials away from edge of excavations. Do not store within drip line or remaining trees.
 - 5. Dispose of excess soil material and waste materials as specified herein.

3.14 COLD WEATHER PROTECTION

- A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.15 BACKFILL AND FILL

- A. General: In the event that there is a shortage of suitable excavated soil material, the Contractor shall import fill materials complying with paragraph 2.1.C of this

specification (except as noted below).

1. The suitability of excavated soil materials for use as fill shall be determined by the Geotechnical Consultant. In any event, the fill materials to be used at various locations are to be as specified in paragraph 2.1.C.
- B. Backfill excavations as promptly as possible, but not until completion of adjoining and related work.
- C. Prior to placing backfill, contractor is to provide Owner's Representative or Geotechnical Engineer with the written anticipated Schedule of Backfill Operations a minimum of forty-eight (48) hours in advance. No backfills shall be placed without the Owner's Representative or geo-technical testing agent at the site.
- D. Backfill excavations promptly, but not before completing the following:
 1. Acceptance of construction below finish grade including, where applicable, damp-proofing, water-proofing, and perimeter insulation, pipe bedding and joints.
 2. Surveying locations of underground utilities for record documents.
 3. Testing, inspecting, and approval of underground utilities.
 4. Removal of all concrete form-work from excavation.
 5. Removal of trash and debris from excavation.
 6. Removal of temporary shoring and bracing and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- E. Place backfill on subgrades free of mud, frost, snow or ice, deleterious/vegetative material.

3.16 PLACEMENT AND COMPACTION

- A. Ground Surface Preparation: Strip and stockpile topsoil. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip/bench sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
- B. Proofrolling: Following the removal of all top soil and prior to the placement of structural fill, the exposed slab subgrade areas and exterior concrete and asphalt paved areas shall be proofrolled and compacted with a smooth surfaced steel drum vibratory roller having a minimum static weight of fifteen (15) tons. Proofrolling shall extend at least ten feet beyond the foundation perimeter. If the proofrolling should

uncover any area which is observed to be soft or unstable, the unstable material shall be removed and replaced as provided in Section 3.1 paragraph A-3.

- C. Placing of Fill Materials: Place the specified structural fill, backfill and soil fill materials in all areas, in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
- D. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.
- E. Place imported structural fill, backfill and fill materials evenly adjacent to structures to required elevations. Prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.
- F. Compaction: Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Architect or Construction Manager if soil density tests indicate inadequate compaction.
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density, in accordance with ASTM D 698:
 - a. Under concrete building slabs, under concrete foundations and footings, compact each layer of imported structural fill material at 98 percent of maximum dry density. Extend compacted area beyond the exterior face of the building a distance equal to the depth of fill at that area but not less than 10 feet.
 - b. Under exterior concrete and asphalt paving compact each layer of backfill or fill material at 98 percent of maximum dry density.
 - c. Under lawn or unpaved areas, compact each layer of backfill or fill material at 95 percent of maximum dry density.
 - d. At exterior face building foundation walls and walls beyond the exterior of the face of the building, each layer of backfill or fill shall be compacted to 95 percent of maximum dry density.
 - e. At asphalt and concrete paving the top 6 to 8 inches of subgrade under the paving and aggregate base course shall be compacted to 98 percent of the maximum dry density. The aggregate base course shall also be compacted to 100 percent of the maximum dry density.
 - 2. Moisture Control: Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within the optimum moisture content. Compact each layer to required percentage of

maximum dry density or relative dry density for each area classification.

- a. Cohesive soil must achieve moisture conditioning before compaction by the addition of water applied uniformly to surface, scarified and mixed by discing or harrowing before compacting. If the soil is too wet to achieve proper compaction, it must be scarified and air dried before compacting, or it must be removed and replaced.
- b. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
- c. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that is too wet to permit compaction to the specified density.
- d. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.
- e. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain ice.

3.17 GRADING

- A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
- B. Establish "Limits of Grading" in the field by installing fence, stakes, flags, or other means acceptable to the Architect.
- C. Grading Inside Building Lines: Finish subgrade to a tolerance of 0.10 foot when tested with a 10 foot straightedge.
- D. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:
 1. Swales: Grade swale bottoms to line and grade as per plan and as directed. Swale bottoms shall be free of undulations and permit free, complete drainage to collection points. At inlets grade swales with gradual approach and without abrupt sumps unless specifically detailed or directed by the Owner Rep. Should field conditions differ from contract documents, the contractor shall advise Owner Representative. Prior to proceeding, for direction and resolution. Maintain accurate grade line and

cross-section of swales during placement of topsoil and seeding operations. Owner Rep. reserves the right to reject and require remedial measures to work which is in noncompliance.

2. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
 3. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
 4. Paved Areas: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.
- E. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.18 FINISH GRADE PREPARATION

- A. The surface grades shall be surveyed in accordance with these specifications and any undulations or irregularities resulting from applications and soil structuring shall be corrected.
1. Spread evenly and grade topsoil to a maximum depth of 8 inches, but not less than a depth of 6 inches.
- B. Cultivate and till the sub-soil to a depth of 4-6 inches (depth may be limited by subsurface conditions).
- C. Regrade, re-firm and grade the soil surface. This is a smoothing and leveling operation to establish the final crown contours and elevations.

3.19 ASPHALT PAVING SUBBASE COURSE

- A. General: Subbase course consists of placing subbase material, in layers of specified thickness, over subgrade surface to support asphalt pavement base course.
1. Refer to other Division 32 Sections for paving specifications.
- B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12-inch width of shoulder simultaneous with the compaction and rolling of each layer of subbase course. Subbase material at asphalt paving shall extend beyond the edge of asphalt paving a dimension equivalent to the thickness of subbase.

- D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
1. When a compacted subbase course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.20 DRAINAGE COURSE

- A. General: Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support building slab.
- B. Placing: Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.
1. When a compacted subbase course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.21 FIELD QUALITY CONTROL

- A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
1. Perform field density tests in accordance with ASTM D 1556 (sand cone method).
 - a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.
 - b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.
 2. Footing Subgrade: For each excavated strata of soil on which footings will be placed, perform at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing

subgrade may be based on a visual comparison of each subgrade with related tested strata when acceptable to Architect.

- a. The bearing surface is to be evaluated by the Geotechnical consultant to confirm that the correct bearing strata has been reached and that the bearing surface is free of loose/soft/disturbed conditions. The evaluation shall be recorded on the daily field report for each foundation element.
3. Building Slabs and Paved Areas Subgrade: Perform at least one field density test of subgrade for every 2,000 sq. ft. of building slabs and paved area, but in no case fewer than three tests. In each compacted fill layer, perform one field density test for every 1,000 sq. ft. of overlaying paved area, but in no case fewer than three tests.
4. Grass Areas: Same frequency as specified for building slabs and paved areas.
5. Walls: One field density test per 100 lineal feet of each side of the wall per foot of backfill or fill.
6. If in opinion of Architect, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained. The additional compaction and testing shall be provided by the Contractor at his expense.

3.22 EROSION CONTROL

- A. Provide erosion control methods in accordance with requirements of authorities having jurisdiction and as specified in Section 311100 "Sedimentation and Erosion Control Systems".

3.23 PROTECTION

- A. Protection of Graded Areas: Protect newly graded areas from traffic freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, settled, rutted or where they lose compaction due to subsequent construction operations or weather conditions.
 1. Scarify or remove and replace soil material to depth as directed by the Architect or Geotechnical Consultant; reshape and recompact.
- C. Where settling occurs during general project warranty period, remove finished surfacing, backfill with additional soil material, compact and reconstruct surface.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.
- D. Protection of Stormwater Infiltration Areas: Protect areas for new stormwater infiltration facilities from compaction.
1. Install temporary construction fencing around bed perimeter to prevent access to excavation and prevent construction equipment from traversing bed area.
 2. Excavate area for infiltration bed, taking care to prevent compaction of soil at facility floor. Bed shall be excavated from perimeter and equipment shall not be permitted to enter facility excavation.

3.24 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, legally dispose of it, off the Owner's property. The Contractor shall obtain approval of the dump site(s) from the Owner's Representative, which approval will not relieve the Contractor of its responsibility herein.

3.25 CLEAN UP

- A. Any paved area (either new or existing) over which hauling operations or other moving equipment are conducted, shall be kept clean and any soil or other material which may be spilled or left upon the paved surfaces shall be removed. Paved surfaces shall be left broom clean. Wet down surfaces as required to prevent excessive airborne dust.

3.26 GEOTECHNICAL ENGINEERING REPORT

- A. Any available data concerning subsurface materials or conditions which is based upon soundings, test pits or test borings, has been obtained by the Owner to assist the Architect in designing this project. Its accuracy or completeness is not guaranteed by the Owner or the Architect and in no event is it to be considered as part of the contract Drawings or Specifications. This information is provided the Contractors for information purposes only.

END OF SECTION 312000

SECTION 312316.13 - TRENCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 RELATED REQUIREMENTS

1.3 DEFINITIONS

1.4 REFERENCES

- A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010.
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
- C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.

1.5 SUBMITTALS

- A. Compaction Density Test Reports.

1.6 DELIVERY, STORAGE, AND HANDLING

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 PREPARATION

3.3 TRENCHING

- A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove excavated material that is unsuitable for re-use from site.
- G. Remove excess excavated material from site.

3.4 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.5 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. At other locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.

3.6 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Utility Piping, Conduits, and Duct Bank

3.7 TOLERANCES

3.8 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- D. Frequency of Tests: As determined by geotechnical engineer.

END OF SECTION 312316.13

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SECTION 312319 – DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
 - 1. Division 31 Section "Earthwork" for excavating, backfilling, and site grading and for test boring data.

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, provide, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Work includes removing dewatering system when no longer needed.
 - 2. Maintain dewatering operations to ensure erosion is controlled, stability of excavations and constructed slopes is maintained, and flooding of excavation and damage to structures are prevented.
 - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 4. Accomplish dewatering without damaging existing buildings adjacent to excavation.

1.4 SUBMITTALS

- A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 2. Include a written report outlining control procedures to be adopted if dewatering problems arise.
 3. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.
- D. Record drawings at Project closeout identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.
- E. Field Test Reports: Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting performance requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform dewatering who has specialized in installing dewatering systems similar to those required for this Project and with a record of successful in-service performance.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services for designing dewatering systems that are similar to those indicated for this Project in material, design, and extent.
1. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for the dewatering system including drawings, testing program, test result interpretation, and comprehensive engineering analysis that shows the system's compliance with specified requirements.
- C. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by the Architect and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project Site Information: A geotechnical report has been prepared for this Project and is available for information only. The report is not part of the Contract Documents. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of the subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, resurvey benchmarks weekly, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

3.2 DEWATERING

- A. Utmost care must be taken to prevent collection and drainage of surface water into excavated or low-lying areas of the site during the excavation and construction. Provide positive drainage from working areas to avoid softening of subgrade soils by water or construction materials.
- B. During construction all excavations shall be backfilled or concreted as soon as possible and all grading depressions should be limited. Low lying areas and excavations shall be pumped out to avoid ponding of water.
- C. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of soil and changes detrimental to stability of subgrades. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.
- D. In the event subsurface water is encountered in footing excavations then large clean aggregate conforming to AASHTO #1 and #57 shall placed and compacted to a level 6" above the groundwater table. Top of the compacted aggregate shall be "choked" with a 6" layer of PennDOT #2A. Compacted modified stone to prevent loss of water and fines from the foundation concrete.
- E. In the event that drainage trenches are insufficient, install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- F. Before excavation below ground-water level, place system into operation to lower water to specified levels and then operate in continuously until drains, sewers and structures have been constructed and fill materials have been places, or until dewatering is not longer required.
- G. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

- H. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner to avoid inconvenience to others. provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- I. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on a continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense.
 - 1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.
- J. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

- A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in area where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 - 1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

END OF SECTION 312319

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SECTION 315000 – EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation support and protection systems.
- B. Related Sections include the following:
 - 1. Division 1 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
 - 2. Division 31 Section "Earthwork" for excavating and backfilling and for existing utilities.

1.3 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.

1.4 SUBMITTALS

- A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.

1. Include Shop Drawings signed and sealed by the qualified professional engineer in the State of Pennsylvania responsible for their preparation.
- B. Qualification_Data: For Installer and professional engineer.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 2. The geotechnical report prepared by Earth Engineering, Inc. dated December 3, 2009. This report is bound in the Non-Technical and Division 01 book.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

- C. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 4 inches.
- D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- E. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER BEAMS AND LAGGING

- A. Drill and Install steel soldier beams before starting excavation. Where rock is encountered, soldier beams shall be anchored minimum Six (6) feet into the rock. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

- B. Install wood lagging within flanges of soldier beams as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally as required and secure to soldier beams.

3.3 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by Architect.
 - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - 1. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

SECTION 321216 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. This Section includes, but is not limited to, the following:
 - 1. Cold milling of existing asphalt paving.
 - 2. New asphalt paving indicated on the drawings.
 - 3. Asphalt pavement overlay.
 - 4. Pavement marking paint.
- B. Extent of hot-mixed asphalt paving work is shown on drawings and hereinafter specified. Asphalt paving may also be identified as "bituminous paving" on the drawings.
- C. Related Sections include the following:
 - 1. Division 31 Section "Site Clearing" for saw-cutting of edges of existing pavement where indicated.
 - 2. Division 31 Section "Earthwork" for prepared aggregate subbase for paved areas.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Job-Mix Design: Certification, by PennDOT and other authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

- D. Material Test Reports: Test reports shall be from the approved testing agency. Indicate and interpret test results for compliance of materials with requirements indicated.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this project and with a record of successful in-service performance.
1. Firm shall be a registered and approved paving mix manufacturer listed in PennDOT Bulletin No. 15.
- B. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Testing Agency Qualifications: Demonstrate to the Owner's satisfaction, based on Owner's evaluation of criteria conforming to ASTM D 3666, that the independent testing agency has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- D. Regulatory Requirements: Comply with Pennsylvania Department of Transportation (PennDOT) standard specifications, Publication 408, latest edition as amended, and with local governing regulations if more stringent than herein specified.
- E. Pre-Construction Conference: Conduct conference at the project site to comply with the requirements of Division 1 sections and to review the methods and procedures related to asphalt paving including but not limited to the following:
1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacturer hot-mix asphalt.
 2. Review condition of substrate and preparatory work performed by other trades.
 3. Review requirements for protecting paving work, including restriction of traffic during installation period for remainder of construction period.
 4. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving installer's personnel, and equipment required to execute the work without delays.
 5. Review inspection and testing requirements, governing regulations, and proposed installation procedures.

6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 1. Prime and Tack Coats: Minimum surface temperature of 60 deg F.
 2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
 3. Asphalt Base or Binder Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 4. Asphalt Wearing Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.
- C. Do not apply pavement markings until after bituminous sealant at curbs and utility structures has cured.
- D. Grade Control: Establish and maintain required lines and elevations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with PennDOT Specifications Publication 408, Sections 700, 800, and 900.

- B. General: Use locally available materials and gradations which exhibit a satisfactory record of previous installations.
- C. Base Course Aggregate: Sound, angular crushed stone, crushed gravel, or crushed slag, sand, stone or slag screenings, complying with ASTM D 692.
- D. Wearing Course Aggregate: Crushed stone, crushed gravel, crushed slag, and sharp-edged natural sand, complying with ASTM D 1073.
- E. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with AASHTO M 17 (ASTM D 242).
- F. Asphalt Cement: AASHTO M 226 (ASTM D 3381) for viscosity-graded material.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to the following:
 - a. Allied Chemical Corp.
 - b. Dow Chemical U.S.A.
 - c. E.I. DuPont De Nemours & Co., Inc.
- G. Tack Coat: Emulsified asphalt, AASHTO M 140 (ASTM D 997) or AASHTO M 208 (D 2397), SS-1, SS-1h, CSS-1 or CSS-1h, diluted with one part water to one part emulsified asphalt.
- H. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA) and PA DEP. Provide granular, liquid or wettable powder form.
- I. Paving Geotextile Fabric: Non-woven polypropylene; resistant to chemical attack, rot, and mildew; conforming to PennDOT Specifications Publication 408, Section 735, for Class 2, Type B.
- J. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10 inch minimum length.

2.2 ASPHALT-AGGREGATE MIXTURE

- A. Warm-Mix Asphalt: Provide in accordance with Section 025220.

2.3 PAVEMENT MARKING – PARKING LOTS, ACCESS ROADS

- A. Coatings for pavement striping and markings shall be in accordance with PennDOT Specification Publication 408, Section 962.
- B. Exterior marking system color shall be determined as follows:
 - 1. Bituminous pavement – White, Type 1, as specified or shown; Blue for ADA spaces.
- C. Coating material shall be fast dry, Latex, designed for marking traffic lanes and spaces on parking lots, streets, highways, and foot traffic control markings.
- D. Approved coating manufacturer shall be the following or approved equal:
 - 1. Benjamin Moore and Company Industrial Coating, M 58 Safety & Zone Marking Latex.
 - 2. Sherwin Williams, Series TM2161 – Selfast Acrylic Latex for Traffic Marking.

2.4 PAVEMENT MARKING – STATE ROADS

- A. Liquid Traffic Paint Markings: Ready-mixed pigmented binder in a single package system suitable for application to traffic bearing surfaces such as Portland cement concrete, asphalt concrete pavements and plain or vitrified brick surfaces of streets, highways, bridges, tunnels, and parking lots.
 - 1. PennDOT Publication 408, Section 962: Type 1 and Type 2.
 - 2. Institute of Transportation Engineers, Equipment and Material Standards of the Institute of Transportation Engineers, “A Model Performance Specification for the Purchase of Pavement Marking Paints and Powders”.
 - 3. Comply with ASTM D 868 and ASTM D 1309.
- B. Glass Beads: Comply with PennDOT Publication 408, Section 962.

2.5 HOT THERMOPLASTIC MARKINGS

- A. Comply with PennDOT Publication 35 (Bulletin 15).
- B. Use hydrocarbon or alkyd based hot thermoplastic markings:
 - 1. Turn arrows, stop bars, crosswalks, gore areas: use alkyd hot thermoplastic markings.

- C. Lead free and cure to a minimum of 99% solids when reacted as per the manufacturer's instructions.
- D. Mixed Material: Cure to a no track condition within 15 minutes when applied at a minimum of 40 mils wet at 77 F.
- E. Markings shall not deteriorate due to exposure to sunlight, water, oil, gasoline, pavement oil content, salt and adverse weather conditions.
- F. Capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures.
- G. Drop on Glass: Depending on the material type used and the applicator device, choice of glass beads for drop shall be as follows:
 - 1. AASHTO M-247, Type 1, standard gradation:
 - a. With adhesion coating for MMA.
 - b. With floatation coating.
 - 2. 80% AASHTO M-247, Type I plus 20% TTB-1235, Type III (1.9 glass):
 - a. With adhesion coating for MMA.
 - b. With floatation coating.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Remove loose material from compacted subbase surface.
- B. Proof roll prepared subbase surface immediately prior to paving to check for unstable areas and areas requiring additional compaction.
- C. Notify Architect of unsatisfactory conditions. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.
- D. Prior to installing the asphalt overlay, the existing paving shall be power washed and power milled, where indicated, in accordance with PennDOT Specification Publication 408, Section 491, to provide a suitable surface to receive the overlay. All milled material debris shall be legally disposed of, off-site. All weeds and cracks shall be treated with the specified herbicide. Fill all cracks with Class AC-20 petroleum asphalt.

- E. Adjust elevation of existing utility structure tops to remain, including but not limited to manholes, inlet grates, valve boxes, etc. to final grades. Depending on the type of utility structure, adjustment shall be accomplished by the installation of factory-fabricated adjustment rings, installation of additional masonry courses under existing manhole castings or inlet tops, or resetting structures. Coordinate with utility owners prior to disturbing existing underground utilities to remain.
- F. All wearing courses and asphalt overlay shall not be installed until just immediately before the date of Substantial Completion. Prepare the binder course same as specified for asphalt overlay except without the power milling.
- G. Tack Coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into asphalt concrete pavement. Apply tack coat to all binder courses before applying wearing course. Distribute at a rate of 0.05 to 0.15 gallons per square yard of surface.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- H. At joints between existing bituminous pavements and new paving work, the edges of existing pavements shall be cut and neatly trimmed. An application of Class AC-20 petroleum asphalt shall be provided at all locations where new bituminous paving joins existing bituminous paving. At joint between paving and concrete curbs provide the same seal coat.
- I. Pavement Markings: Removal of pavement markings shall comply with PennDOT Specification Publication 408, Section 962.

3.2 PLACING MIX

- A. General: Place in accordance with Section 025220 Warm Mix Asphalt.
- B. Paver Placing: Place in strips not less than 10' wide, unless otherwise acceptable to Architect. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing wearing course.
- C. Joints: Make joints between old and new pavements or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of asphalt course. Clean contact surfaces and apply tack coat.

- D. Courses: Apply paving in separate courses, each separately rolled and compacted. The specified and indicated thicknesses are compacted thicknesses.
1. Binder Courses: See drawings for compacted thickness.
 2. Wearing Courses: See drawings for compacted thickness.
 3. BCBC Courses: See drawings for compacted thickness.
 4. Asphalt Pavement Overlay: 1-1/2 inch compacted thickness.

3.3 PAVEMENT COMPACTION

- A. General: Begin rolling when mixture will bear roller weight without excessive displacement.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.
- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
- E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density. Complete compaction before mix temperature cools to 185 deg F.
- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot asphalt paving. Compact by rolling to maximum surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Joint Sealing: Joint between new and existing paving shall be sealed with an approved asphalt sealing compound.
- I. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
- J. Seal coat material shall be rolled smooth ridges and provide a uniform surface.

3.4 TRAFFIC AND LANE MARKINGS

- A. Allow paving to age for 30 days before starting pavement marking.
- B. Cleaning: Sweep and clean surface to eliminate loose material and dust.
- C. Apply traffic lines and markings in accordance with PennDOT Specification Publication 408, Section 962 and PennDOT Publication 68.
- D. Do not apply traffic and lane marking paint until layout and placement has been verified with Architect.
- E. Apply paint with mechanical equipment to produce uniform straight edges. Apply in a wet film thickness of 15 mils.
 - 1. Include all markings as directed by the Architect and indicated on the drawings.
- F. Glass Beads: Apply glass beads at a rate of six pounds per gallon of paint, where indicated.
- G. Hot Thermoplastic Markings:
 - 1. Apply primer at manufacturer's recommended rate.
 - 2. Apply at temperature between 400 to 440 F.
 - 3. Thickness:
 - a. New Application: 90 mils.
 - b. Over Existing Markings: 30 mils.
 - 4. Drop On Glass Beads:
 - a. Application Rate: 8 to 10 lbs per 100 square feet.
 - b. Apply evenly to a depth of 50 to 60 percent.
 - 5. Maximum Holding Time: 6 hours.
 - 6. Maximum Temperature: 450 F.

3.5 WHEEL STOPS

- A. Securely attach wheel stops to pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into

pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.6 FIELD QUALITY CONTROL

- A. General: Test in-place asphalt courses for compliance with requirements for thickness, compaction and surface smoothness. Repair or remove and replace unacceptable paving as directed by Architect. Costs involved for testing shall be borne by the Owner.
- B. Core Testing:
 - 1. Binder Course: The Owner shall have the paving cored by an approved laboratory. Two cores will be taken for each day's production. The cores will be tested for thickness and density and the results given to the Architect. Any deficiencies from specified thickness by 1/2 inch or more will require the section represented to be replaced by the Contractor. The average density of the cores shall be $\geq 88\%$ of the theoretical density. The Contractor will replace any deficient sections. Core holes shall be properly patched.
 - 2. Wearing Course: Density testing shall be by nuclear gauge. $\geq 92\%$ or $< 97\%$ of theoretical density is required. Deficient sections shall be replaced.
- C. Surface Smoothness: Test finished surface of each asphalt course for smoothness, using 10' straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness.
 - 1. Base Course Surface: 1/4 inch.
 - 2. Wearing Course Surface: 3/16 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template, 1/4 inch.
 - 4. Check surface areas at intervals as directed by the Architect.

3.7 CLEANUP

- A. Remove bituminous material from utility structure frames and covers. Open and reset utility manhole covers and inlet grates to ensure castings are not sealed shut.

- B. Clean up debris and unused material and remove from the site. Dispose of all material in accordance with local, state, and federal regulations. Do not dump material in manholes or inlets.

END OF SECTION 321216

SECTION 321726 – TACTILE WARNING SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The extent of work under this Section is shown on the drawings and hereinafter specified.
- B. Included in this work is, but is not limited to, the following:
 - 1. Cast-in-Place Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Cement concrete paving substrate is specified in Division 32 Section " Cement Concrete Pavement".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Samples for Verification Purposes: Submit two (2) tile samples minimum 6"x6" of the kind proposed for use.
- C. Shop Drawings: For products specified showing fabrication details, composite structural system, tile surface profile, sound on cane contact amplification feature, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.
- D. Material Test Reports: Submit complete test reports from qualified accredited independent testing laboratory's to qualify that materials proposed for use are in compliance with requirements and meet or exceed the properties indicated on the specifications. All tests shall be conducted on a Cast In Place Detectable/Tactile Warning Surface Tile system as certified by a qualified independent testing laboratory and be current within a 24 month period.

- E. Maintenance Instructions: Submit copies of manufacturer's specified installation and maintenance practices for each type of Detectable Warning Surface Tile and accessory as required.

1.5 DELIVERY AND STORAGE

- A. Cast In Place Detectable/Tactile Warning Surface Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.
- B. Cast In Place Detectable/Tactile Warning Surface Tiles shall be delivered to location at building site for storage prior to installation.

1.6 PROJECT CONDITIONS

- A. Maintain minimum temperature of 40°F in spaces to receive Cast In Place Detectable/Tactile Warning Surface Tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

1.7 WARRANTY

- A. Submit written warranty covering all materials and workmanship against defects or failures of any nature for the period indicated. Warranty shall include defective work, breakage, deformation, fading and loosening of tiles.
1. Period: Five years from the Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
1. Manufacturer: Engineered Plastics, Inc.
- a. Product: Cast-in-Place Detectable/Tactile Warning Surface Tiles; Armor-Tile.

2.2 MATERIALS

- A. Vitrified Polymer Composite (VPC) Cast In Place Detectable/Tactile Warning Surface Tiles shall be an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.9" base diameter, and 0.45" top diameter, spaced center-to-center 2.35" as measured on a diagonal and 1.67" as measured side by side.
 - 1. Size: As indicated on the contract drawings.
 - 2. Color: As selected by the Architect using one color for the entire project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to placement of the Cast In Place Detectable/Tactile Warning Surface Tile system, review manufacturer and contract drawings with the Contractor prior to the construction and refer any and all discrepancies to the Engineer.

3.2 INSTALLATION

- A. The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 - 7 to permit solid placement of the Cast In Place Detectable/Tactile Warning Surface Tile system. An overly wet mix will cause the tile to float. Under these conditions, suitable weights such as 2 concrete blocks or sandbags (25 lb) shall be placed on each tile.
- B. The concrete pouring and finishing operations require typical mason's tools, however, a 4' long level with electronic slope readout, 25 lb. weights, and a large non-marring rubber mallet are specific to the installation of the Cast In Place Detectable/Tactile Warning Surface Tile system. A vibrating mechanism such as that manufactured by Vibco can be employed, if desired. The vibrating unit should be fixed to a soft base such as wood, at least 1 foot square.
- C. The factory-installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.
- D. When preparing to set the tile, it is important that no concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes in the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each embedment flange on the underside of the tile. This will lock the tile solidly into the cured concrete.
- E. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing

concrete, the electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. The Cast In Place Detectable/Tactile Warning Surface Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

- F. While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.
- G. During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning or external forces placed on the tile that may rock the tile causing a void between the underside of tile and concrete.
- H. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two suitable weights of 25 lb each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.
- I. Following the concrete curing stage, protective plastic wrap is to be removed from the tile surface by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft brass wire brush will clean the residue without damage to the tile surface.

3.3 CLEANING, PROTECTING AND MAINTENANCE

- A. Protect tiles against damage during construction period to comply with Tactile Tile manufacturer's specification.
- B. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- C. Clean Tactile Tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean Tactile Tile by method specified by Tactile Tile manufacturer.
- D. Comply with manufacturers maintenance manual for cleaning and maintaining tile surface and it is recommended to perform annual inspections for safety and tile integrity.

END OF SECTION 321726

SECTION 321823 - ATHLETIC AND RECREATION SURFACES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rubberized pour-in-place resilient surfacing.

1.2 RELATED SECTIONS

1.3 REFERENCES

- A. ASTM D422 – Particle Size Analysis of Soils.
- B. ASTM D2434 – Standard Test Method for Permeability of Granular Soils.
- C. ASTM F1292 – Impact Attenuation of Surface Systems Under and Around Playground Equipment.
- D. ASTM PS-83 – Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.

1.4 SUBMITTALS

- A. Bituminous or Concrete Paved Play Area and Playground Color Surfacing System:
 - 1. Product Data: Submit product data, manufacturer's installation instructions and specifications, standard color samples, catalog cuts or manufacturer's standard shop drawings as required by Section 01330.
- B. Synthetic or Rubberized Pave-in-place, Pour-in-place, and Tile Paver Resilient Surfacing:
 - 1. Product Data: Submit product data, manufacturer's installation instructions and specifications, standard color samples, catalog cuts or manufacturer's standard shop drawings as required by Section 01330.
 - 2. Certified laboratory test results for Impact Attenuation – ASTM F1292-99 and ASTM 1292-96, Accessibility, ASTM F-1951-99, Coefficient of Friction, ASTM D2047-82, Permeability, Flammability, ASTM D2859, and Tensile Strength, ASTM D412-87.

3. Manufacturer's written warranty.

1.5 QUALITY ASSURANCE

- A. Products specified in this section shall be installed by the manufacturer or installers certified by the manufacturer where such certification is available. Company installing products of this section shall have a minimum of five years documented experience with installation of the type of product specified unless noted otherwise in this Section.
- B. Manufacturer Representation: Manufacturer shall provide periodic observation or certification that Contractor is licensed installer for the following products:
 1. Poured Rubber Resilient Surfacing.

PART 2 PRODUCTS

2.1 RUBBERIZED RESILIENT SURFACING

- A. Sub-base: stone with drainage system as scheduled on Drawings.
- B. Resilient Surfacing: Poured seamless rubber surfacing manufactured from pre-consumer and post consumer recycled rubber materials.
 1. Impact Layer: SBR or EPDM select rubber, free of foreign matter, with polyurethane binder. Depth of material as scheduled on Drawings.
 2. Wearing Layer: EPDM pigmented synthetic rubber granules with a minimum weight of 2.2 lbs. per square foot.

Minimum Thickness: 1/2-inch

Color/Pattern: Manufacturer's standard colors, colors and pattern as scheduled on Drawings.
 3. Primer and Binder: 100-percent single component polyurethane.
 4. Physical Properties:
 - a. Minimum Tensile Strength: 60 PSI

- b. Minimum Elongation at Break: 140-percent
 - c. Flammability: Pass
 - d. Coefficient of Friction: 0.9-Wet, 1.0-Dry
 - e. Minimum Water Permeability: 0.4 gal./sq. yd./sec.
- C. Warranty: Seven (7) year minimum manufacturer's warranty against defective materials or workmanship.
- D. Manufacturer's and Products:
- 1. Surface America PlayBound Poured-in-Place as distributed by Recreation Resource USA, Kennett Square, PA 610-444-4402
 - 2. GameTime GT Impax Poured Recycled Surfacing as distributed by Biting Recreation, Harrisburg, PA, 800-248-8464, or equal.

PART 3 EXECUTION

3.1 VERIFICATION

- A. Verify that subgrade is prepared, subdrainage installed, and elevations correct prior to installing infield mix.

3.2 PROJECT CONDITIONS

- A. Delivery and Storage: All surfacing coatings in sealed containers with the manufacturer's label affixed. Store in where placement will not interfere with other Work and where environmental conditions are appropriate for the material.
- B. Notification: Notify Architect a minimum of 48-hours prior to installation of any acrylic or synthetic surfacing materials.

3.2 INSTALLATION

- A. Poured Rubber Resilient Surfacing
- 1. Coordination: Coordinate installation of play surfacing with installation of play equipment (by owner), drainage, and utility installations that may affect Work.
 - 2. Install sub-base stone in accordance with manufacturer specifications and tolerances.

3. Install impact course to the depth scheduled on the Drawings or in accordance with CPSC and ASTM F1292-99 Critical Height requirements.
4. Install wearing course of colors and in pattern as scheduled on Drawings. Install wear course to minimum 3/8-inch thickness.
5. Wear course shall be smooth and free of irregularities, depressions, and foreign matter that affect finished appearance of surface.
6. Provide cold joint seam at areas of color transition or for large pours. Color transition lines shall be smooth and regular.
7. Edges shall be flush with adjoining paving or surfaces. Taper edges where indicated on Drawings.
8. Surface Drainage: Slope finished surface as scheduled on Drawings.
9. Protect finished surface immediately after installation and until accepted by Owner.

END OF SECTION 321823

SECTION 323110 – CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Polyvinyl chloride (PVC) coated steel chain-link fabric.
 - 2. Polyvinyl chloride (PVC) coated steel framework.
- B. Related Sections include the following:
 - 1. Division 31 Section "Earthwork" for site excavation, fill, and backfill where chain-link fences and gates are located.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Chain-link fabric, reinforcements, and attachments.
- B. Shop Drawings: Show locations of gates, posts, rails, details of extended posts, gate swing, hardware, and accessories.
- C. Samples for Initial Selection: Manufacturer's color charts or 6-inch lengths of actual units showing the full range of colors available for components with factory-applied color finishes.
- D. Maintenance Data: For the following to include in maintenance manuals.
 - 1. Polyvinyl chloride finish.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed chain-link fences similar in material, design, and extent to those indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Master Halco.
 2. Merchants Metals.
 3. Boundary Fence & Railing Systems, Inc.

2.2 CHAIN-LINK FENCE FABRIC

- A. Fence Height: Height indicated on drawings, measured from finished grade to top of fabric. Bottom of fabric shall be not more than 3/4" above finished grades.
- B. Selvage: Knuckled at both selvages.
- C. Steel Fabric: Comply with Chain Link Fence Manufacturers Institute (CLFMI) Product Manual. Furnish one-piece fabric widths for fencing up to 12 feet high. Wire size includes zinc coating, but does not include the Polyvinyl Chloride (PVC) coating.
1. Size: 2-inch mesh, 9-gage (0.148-inch diameter) wire.
 2. Galvanized Steel Finish: ASTM A 392, Class 2, with not less than 2.0 oz. zinc per sq. ft. of uncoated wire surface on wire coated before weaving or not less than 2.0 oz. zinc per sq. ft. of uncoated wire surface on wire of fabric coated after weaving as determined from the average of two or more samples and not less than 1.8 oz. zinc per sq. ft. of uncoated wire surface for any individual sample.
 3. Polyvinyl Chloride (PVC) Finish: Comply with ASTM F 668 Class 2B, with

core wire diameter (gage) measured prior to application of PVC coating with not less than 0.40 oz. zinc per sq. ft. of uncoated surface on 6 gage wire and not less than 0.30 oz. zinc per sq. ft. of uncoated surface on 9 gage wire.

- a. Class 2b, 0.006- to 0.010-inch-thick PVC coating fused and adhered to zinc-coated steel wire.
- b. Color: Selected by Architect from manufacturers standard colors.

2.3 FENCE FRAMING

- A. Strength requirements for posts and rails conforming to ASTM F 669.
- B. Pipe shall be straight, true to section, material, and sizes specified, and shall conform to the following weights per foot:

NPS in inches	Outside Diameter (OD) in inches	Weight/Foot
1-1/4	1.660	2.27
1-1/2	1.900	2.72
2	2.375	3.65
2-1/2	2.875	5.79
3-1/2	4.000	10.79

- C. Steel Framework, General: Posts, rails, and braces.
 1. Type I Pipe: Hot-dipped galvanized steel pipe conforming to ASTM F 1083, plain ends, standard weight (schedule 40) with not less than 1.8 oz. zinc per sq. ft. of surface area coated. All pipe shall be Type I.
 2. Polyvinyl Chloride (PVC) Finish: Provide framework, fittings, and accessories with manufacturer's standard polyvinyl chloride (PVC) plastic resin finish thermally bonded and adhered to a cured primer applied over zinc-coated steel, not less than 10 mils (0.010-inch) thick. Color to match chain link fabric.
- D. Gate Posts: Furnish posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:
 1. Up to 6 Feet: 2.875 inch OD steel pipe, 5.79 lb/ft.
 2. 6 Feet to 12 Feet: 4.00 inch OD steel pipe, 9.11 lb/ft.

2.4 GATES

- A. Fabrication: Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware, and accessories. Space frame members maximum of 8 feet apart

unless otherwise indicated.

1. Provide steel fabric as for gates unless otherwise indicated. Install fabric with tension bars and bands at vertical edges and at top and bottom edges.
2. Install diagonal cross-bracing consisting of 3/8-inch diameter adjustable-length truss rods on gates to ensure frame rigidity without sag or twist.

B. Swing Gates: Comply with ASTM F 900.

1. Fabricate perimeter frames of minimum 1.875-inch OD steel pipe.
2. Gate Hardware: Provide hardware and accessories for each gate, galvanized per ASTM A 153, and in accordance with the following:
 - a. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180-deg gate opening. Provide 1-1/2 pair of hinges for each leaf over 6-foot nominal height.
 - b. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch. Padlock by Owner.

2.5 FITTINGS AND ACCESSORIES

- A. Material: Comply with ASTM F 626. Galvanized iron or steel, to suit manufacturer's standards.
1. Zinc Coating: Unless specified otherwise, galvanize steel fence fittings and accessories in accordance with ASTM A 153, with zinc weights per Table I.
 2. PVC Coating: All fittings and accessories shall be polyvinyl coated same as specified for fabric and framing members. PVC coating shall be fused to the surface.
- B. Tie Wires: 12-gage (0.106-inch diameter) galvanized steel with a minimum of 0.80 oz. per sq. ft. of zinc coating of surface area in accordance with ASTM A 641, Class 3.
- C. Post Caps: Provide weathertight closure cap for each post. Provide line post caps with loop to receive top rail. Caps shall be shaped as directed by the Architect.
- D. Tension and Brace Bands: Minimum 3/4-inch-wide hot-dip galvanized steel with minimum 1.2 oz. zinc coating per sq. ft. of surface area.
1. Tension Bands: Minimum 14 gage (0.074 inch) thick.

2. Tension and Brace Bands: Minimum 12 gage (0.105 inch) thick.
- E. Concrete: Provide concrete consisting of Portland cement, ASTM C 150, aggregates ASTM C 33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 2500 psi. Use at least 4 sacks of cement per cu. yd., 1-inch maximum size aggregate, maximum 3-inch slump, and 2 to 4 percent entrained air.
- F. Grout: Nonmetallic, non-corrodible, non-shrink, factory blended and packaged; complying with ASTM C 1107; recommended by manufacturer for exterior use.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for concrete work, and other conditions affecting performance.

3.2 INSTALLATION

- A. General: Install fence in compliance with ASTM F 567. Do not begin installation and erection before final grading is completed, unless otherwise permitted.
- B. Excavation: Drill or hand-excavate (using post-hole digger) holes for posts in firm, undisturbed or compacted soil.
 1. If not indicated on drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than 12 inch diameter.
 2. Unless otherwise indicated, excavate hole depths approximately 3 inches lower than post bottom, with bottom of posts set not less than 36 inches below finish grade surface.
- C. Pipe Sleeves: Set pipe sleeves in core of concrete and grout in place.
- D. Setting Posts: Center and align posts in holes 3 inches above bottom of excavation. Space maximum 10 feet o.c., unless otherwise indicated.
 1. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
 - a. Unless otherwise indicated, extend concrete footings 2 inches above grade and trowel to a crown to shed water.
 - b. Remove concrete forms and backfill all concrete.

- c. At pipe sleeves set posts in place and grout the posts to the sleeve. Build up exposed surface of grout to slope away from post. Seal grout exposed to weather in accordance with manufacturer's instructions.
- E. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.
- F. Fabric: Leave not more than 3/4 inches between finish grade and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts and rails. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.
- G. Tie Wires: Use U-shaped wire of proper length to secure fabric firmly to posts and rails with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.
 - 1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to rails and braces 24 inches o.c.
- H. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.3 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.4 ADJUSTING

- A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 323110

SECTION 323120 – ORNAMENTAL PICKET FENCE & SWING GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Ornamental picket fence system.
 - 2. Ornamental picket swing gates.
- B. Related Sections include the following:
 - 1. Division 32 Section “Cast-In-Place Concrete” for concrete for fence post footings.

1.3 SUBMITTALS

- A. Product Data: Include material descriptions, construction details, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show locations of ornamental picket fencing, posts, hardware and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, and other required installation clearances, and details of post anchorages.
- C. Samples for Initial Selection: Actual color samples for polyester coated finishes on materials to be furnished for Architects selection from the manufacturer’s full range of colors. If requested, samples of fence components delivered to customer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed ornamental picket fencing and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Preinstallation Conference: Conduct conference at project site to comply with requirements in Division 1 Section “Project Meetings”.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for ornamental picket fencing and gates shown on the Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.6 DELIVERY AND HANDLING

- A. Deliver and handle materials in a manner that will not damage the materials and finishes.

1.7 WARRANTY

- A. The entire fence system shall have a written Limited Lifetime Warranty against rust and defects in workmanship and materials. In addition, the finish shall be warranted not to crack, chip, peel, or blister for the same period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited, to the following:
 - 1. Basis of Design: Iron World, 9390 Davis Ave. Howard County, MD 20743 (phone (301) 766- 7448; fax (301)776-7449; web-site: www.IronWorldFencing.com).
 - a. Style: Aberdeen Maverick Supreme Plus – 3 horizontal rail, smooth top rail.
 - b. Height 4' and 6' (see plan for locations).
 - 2. Additional qualified manufacturers having a minimum of 5 years experience manufacturing ornamental picket fencing will be reviewed by the customer to determine conformity to the following specifications for design, size, gauge of metal parts and fabrication as an approved equivalent. The following manufacturers are considered to be an approved equivalent:
 - a. AmeriStar Fence
 - b. Master Halco
 - c. Long Fence

2.2 ORNAMENTAL PICKET FENCE

- A. Pickets: Fabricated of galvanized steel tubular members per ASTM A787 with a G60 zinc coating 0.60 oz/ft² and steel to have 45,000 psi (310 Mpa) yield strength. Picket size shall be 3/4" or 1" sq x 16 or 18 gauge wall thickness, and spaced at 3 15/16" face to face. Pickets shall be attached to rails using 1/4" industrial drive rivets.
- B. Rails: Horizontal U" channels shall be 1 1/2" x 1 3/8" x 1 1/2" 15 gauge wall thickness (.072") and galvanized: G60 zinc coating 0.60 oz/ft², manufactured per ASTM A-653/A-653M with a 50,000 psi (344 MPa) yield strength. Rails shall be mechanically punched to receive pickets and drive rivets. Attach rails to brackets using one-way security fastener.
- C. Posts: Fabricated of galvanized square steel tubular members per ASTM A787 with a G60 zinc coating, 0.60 oz/ ft² and steel to have 45,000 psi (310 MPa) yield strength. Post size options (3" sq x 12 gauge) or (2 1/2" square 14 or 12 gauge) wall thickness.
- D. Finish: All posts, caps and fence panels shall be polyester coated individually after fabrication to thoroughly coat all surfaces for additional corrosion protection. All components enter a 5 stage in line cleaning process to prepare the galvanized surfaces for complete adhesion of the finish coat. Components are given a TGIC polyester resin powder coating applied by the electrostatic spray process to 3.0 mil thickness. The finish is baked in an oven for 15 — 20 minutes at a temperature ranging from 400°F. Colors are available in black or white (brown, ensor green, woodland green and specials).

2.3 ACCESSORIES

- A. Post Caps: Aluminum or formed steel manufactured to form a weather-tight closure. Caps shall be ball type or flat top (choose one) style on each post.
- B. Rail/Post Brackets: Standard 1 1/2" x 1 3/8" x 1 1/2", 15 gauge galvanized steel channels. Cover to be pressed to bracket for permanent installation. Bracket shall be fastened to post with one galvanized hex bolt. Rails shall be attached to bracket with one-way security fastener.
- C. Rings: Cast aluminum rings attached to rails by insertion of mounting block into upper rail. Rings attached to rails with standard drive rivet to prevent removal.
- D. Pickets shall be secured to rails with 1/4" aluminum industrial drive rivets to prevent movement. Rivets have a sheer strength of 1,500# and a holding power of 1,100#.

2.4 ORNAMENTAL PICKET SWING GATES

- A. Gate Frame: Ornamental picket swing gate frames to be fabricated of galvanized steel tubing. ASTM A-653, of structural steel having a 45,000 psi (310 Map)

tensile strength and a G60 [0.60 oz/ft² zinc coating. Members welded with stainless steel rods, forming a rigid one piece unit. Vertical upright member's 2"sq. 13ga. metal thickness.

B. Horizontal rails and pickets.

1. For gate leaves up to 8'0" the horizontal rails to be "U" channels, formed of hot rolled, structural steel 1 3/8" wide by 1 1/2" high, 11 gauge [0.120"] metal thicknesses. Rails must be punched to receive pickets and rivets. Rails stainless steel welded inside vertical members. Pickets are galvanized steel [choose one: 3/4" or 1" to match fence sections.] Pickets attached to "U" channels using 1/4" industrial drive rivets.
2. For gate leaves 8'1" up to 12'0" provide an additional 1 1/2" sq. stiffener welded to one top and one bottom "U" channel. Use stainless steel rods for welds.
3. For gate leaves 12'1" to 18'0" supply 2 additional 2" sq. horizontal members welded to the 2" sq. vertical members forming a 2" sq. rectangular frame. Welds to be stainless steel.
4. For gate leaves 18'1" to 24' 0" 2 additional horizontal stiffeners 2' sq. to be welded behind 2" horizontal members. Welds to be stainless steel.
5. Bracing: Provide diagonal adjustable length truss rods to prevent sagging. One truss rod per 8' maximum of length of gate panel.
6. Double gates consist of 2 each of the above gate leaves.

C. Hardware: Galvanized steel and or malleable steel to suit application. Latch shall have provision for padlocking. Hinges shall grip post and frame firmly to prevent slippage. Hinges shall have a load capacity of 1,000 lbs. Hinges shall allow gate leaf to swing 180°.

D. Gate keepers shall be provided for any leaf wider than 5'0' to hold gate in open position.

E. Double leaf gates to have center drop rod to enable one leaf to be made stationary while that latch shall lock both leaves together.

F. Gate Posts: Square gate posts (ASTM A-653) 45,000 psi (MPa) tensile strength with G90 galvanized coating in sizes shown below:

1. 3" sq. for gate leaf sizes 3'0" to 4'0"
2. 4" sq. for gate leaf sizes 4'1" to 8'0"
3. 6" sq. for gate leaf sized 8'0" to 12'0"
4. 8" sq. for gate leaf sized 12'1" to 18'0"

5. 10" sq. for gate leaf sizes 18'0" to 24'0"

- G. Finish: All steel parts to be galvanized to prevent corrosion. Next, pre-treat and clean surfaces to accept finish coat. Apply 3 mils of TGIC polyester powder coating applied by electrostatic spray process baked at 450° F until finished is cured onto metal. Gates to be coated after all welding is completed.

2.5 POST SETTING

- A. Concrete: Minimum 28-day compressive strength of 2,500 psi.
- B. Plated Post: Provide 3/8" steel base plates with 4 holes for surface mounting where indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with installer present, for compliance with requirements for concrete work, and other conditions affecting performance.
1. Do not begin installation before final grading is completed, unless permitted by the architect.

3.2 FENCE INSTALLATION

- A. Install fence in accordance with the manufacturer's instructions.
- B. Set post uniformly at 93 1/8" face to face unless otherwise indicated.
- C. Set posts in concrete having a diameter 4 times the diameter of the post, and 6" deeper than the bottom of the post. Forms are not necessary or recommended.
- D. Check each post for vertical and top alignment.

3.3 GATE INSTALLATION

- A. Install gate posts a minimum of 36" into firm soil. The diameter of the footing to be 4 times the diameter of the post. Footing should be 6" deeper than the bottom of the posts, 42". Finish concrete with a slop for all water to drain away from post.
- B. Attach all hardware to gate in such a way that it cannot be removed by unauthorized persons.

- C. Set gate posts plumb and level for gate openings specified in construction drawings.
- D. Install gates to allow full opening without interference after concrete has hardened around gate posts. Adjust hardware for smooth operation. Install one drop rod for double gates.

3.4 ADJUSTING AND PROTECTION

- A. Adjust gate to operate smoothly and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, disruption, or malfunction, throughout entire operation range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Protect complete installation against damage until the date of substantial completion.

3.5 CLEANING

- A. Clean up debris and remove from the site.

END OF SECTION 323120

SECTION 32 32 23 - SEGMENTAL BLOCK RETAINING WALLS

PART 1 - GENERAL

1.01 Description

- A. Work shall consist of designing, furnishing and construction of a segmental block unit retaining wall system in accordance with these specifications and in reasonably close conformity with the lines, grades, design and dimensions shown on the plans. No alternate wall systems will be considered.
- B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit facing system, unit drainage fill and reinforced backfill to the lines and grades shown on the construction drawings.
- C. Work includes furnishing and installing geogrid soil reinforcement of the type, size, location and lengths designated on the construction drawings.

1.02 Related Sections

- A. Section 31 00 00 – Earthwork

1.03 Reference Documents

- 1. American Association of State Highway and Transportation Officials (AASHTO)
- 2. AASHTO M 252 Corrugated Polyethylene Drainage Pipe
- 3. AASHTO M 288 Geotextile Specification for Highway Applications
- 4. American Society for Testing and Materials (ASTM)
- 5. ASTM C140 Sampling and Testing Concrete Masonry Units
- 6. ASTM C1372 Specification for Dry-Cast Segmental Retaining Wall Units
- 7. ASTM D442 Particle Size Analysis of Soils
- 8. ASTM D698 Laboratory Compaction Characteristics of Soil – Standard Effort
- 9. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil In Place by the Sand Cone Method
- 10. ASTM D1557 Laboratory Compaction Characteristics of Soil – Modified Effort

11. ASTM D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
12. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
13. ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer pipe and Fittings
14. ASTM D4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils
15. ASTM D4475 Horizontal Shear Strength of Pultruded Reinforced Plastic Rods
16. ASTM D4476 Flexural Properties of Fiber Reinforced Pultruded Plastic Rods
17. ASTM D4595 Standard Test Method for Tensile Properties of Geotextiles by Wide-Width Strip Method
18. ASTM D4873 Standard Guide for Identification, Storage and Handling of Geosynthetics
19. ASTM D5262 Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
20. ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
21. ASTM D5818 Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage
22. ASTM D6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Method
23. ASTM D6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units
24. ASTM D6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
25. ASTM D6916 Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units

B. National Concrete Masonry Association (NCMA)

1. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW
2. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW

1.04 Definitions

- A. Unit – a dry-stacked concrete retaining wall unit machine made from Portland cement, water, aggregates, manufactured by a licensed manufacturer of Keystone, Allan Block or approved equal.
- B. Structural Geogrid – a polymeric material formed by a regular network of connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.
- C. Unit Drainage Fill – drainage aggregate that is placed within and immediately behind the concrete units.
- D. Reinforced Backfill – compacted soil that is placed within the reinforced soil volume as outlined on the plans.
- E. Retained Soil – the soil mass behind the reinforced backfill.
- F. Foundation Soil – the soil mass below the leveling pad and reinforced backfill.
- G. Leveling Pad – crushed stone, sand and gravel or unreinforced concrete material placed to provide a level surface for placement of the concrete units.
- H. Geosynthetic Reinforcement – polymeric material designed specifically for soil reinforcement.

1.05 Submittals and Certification

- A. Contractor shall submit a Manufacturer's certification, prior to the start of work, that the retaining wall system components meet the requirements of this specification and the structure design.
- B. Contractor shall submit construction drawings and design calculations for the retaining wall system prepared and stamped by a Professional Engineer registered in the state of the project.
- C. Contractor shall submit product samples including color palette for selection by owner.

1.06 Quality Assurance

- A. Contractor shall submit a list of five (5) previously constructed projects of similar size and magnitude by the wall installer where the retaining wall system has been constructed successfully. Contact names and phone numbers shall be listed for each project.
- B. Contractor shall provide evidence that the design engineer has a minimum of five years documented experience in the design of reinforced soil structures. The

design engineer shall provide proof of current professional liability insurance with an aggregate coverage limit of not less than \$2,000,000.

- C. Owner shall provide quality assurance inspection and testing during earthwork and wall construction operations. Contractor shall provide all quality control testing and inspection not provided by the owner. Owner's quality assurance program does not relieve the contractor of responsibility for quality control and wall performance.

1.07 Delivery Handling and Storage

- A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification have been received.
- B. Contractor shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

PART 2 - PRODUCTS

2.01 Concrete Block Retaining Wall Units

- A. Retaining wall units shall conform to the following architectural requirements

- 1. Face color - The Owner shall specify standard manufacturers' color.
- 2. Straight Face finish - Other face finishes will not be allowed without written approval of Owner.
- 3. Bond configuration - running with bonds nominally located at midpoint in vertically adjacent units.
- 4. Exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 20 feet (6 m) under diffused lighting.

- B. Concrete units shall conform to the requirements of ASTM C1372 - Standard Specifications for Segmental Retaining Wall Units.

- C. Concrete units shall conform to the following structural and geometric requirements measured in accordance with ASTM C140 Sampling and Testing Concrete Masonry Units:

- 1. Compressive strength: ≥ 3000 psi (21 MPa).
- 2. Absorption: ≤ 8 % for standard weight aggregates.
- 3. Dimensional tolerances: $\pm 1/8$ " (3 mm) from nominal unit dimensions not including rough split face.
- 4. Unit Size: 8" (203 mm) (H) x 18" (457 mm) (W) x 18 to 21.5" (304 to 546 mm)(D) minimum.

- D. Concrete units shall conform to the following constructability requirements:

1. Vertical setback: 1/8 inch (3 mm) ± per course (near vertical) or 1 1/8 inch (28 mm) + per course, per the design.
2. Alignment and grid attachment mechanism - fiberglass pins, two per unit.
3. Maximum horizontal gap between erected units shall be ≤ 1/2 inch (13 mm).

2.02 Shear and Reinforcement Pin Connectors

- A. Shear and reinforcement pin connectors shall be 1/2-inch (12 mm) diameter thermoset isophthalic polyester resin pultruded fiberglass reinforcement rods to provide connection between vertically and horizontally adjacent units and geosynthetic reinforcement, with the following requirements:
1. Flexural Strength in accordance with ASTM D4476: 128,000 psi (882 MPa) minimum.
 2. Short Beam Shear in accordance with ASTM D4475: 6,400 psi (44 MPa) minimum.
- B. Shear and reinforcement pin connectors shall be capable of holding the geogrid in the proper design position during grid pre-tensioning and backfilling.

2.03 Base Leveling Pad Material

- A. Material shall consist of a compacted crushed stone base, sand and gravel or unreinforced concrete, as shown on the construction drawings.

2.04 Unit Drainage Fill

- A. Unit drainage fill shall consist of clean 1 inch (25 mm) minus crushed stone or crushed gravel meeting the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 inch (25 mm)	100
3/4-inch (19mm)	75 – 100
No. 4 (4.75 mm)	0 – 10
No. 50 (300 um)	0 - 5

- B. Drainage fill shall be placed within the cores of, between, and behind the units as indicated on the design drawings. Not less than 1.2 cubic foot (0.033 m³), of drainage fill shall be used for each square foot (0.093 m²) of wall face unless otherwise specified.

2.05 Reinforced Backfill

- A. Reinforced backfill shall be free of debris and meet the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 1/2 inch (38 mm)	100
3/4-inch (19 mm)	75 – 100
No. 40 (425 um)	0 – 60
No. 200 (75 um)	0 – 35

Plasticity Index (PI) < 15 and Liquid Limit < 40, per ASTM D4318

- B. The maximum aggregate size shall be limited to 3/4 inch (19 mm) unless installation damage tests have been performed to evaluate potential strength reductions to the geogrid design due to increased installation damage during construction.
- C. Material can be site-excavated soils where the above requirements can be met. Soils not meeting the above criteria, including highly plastic clays and organic soils, shall not be used in the backfill or reinforced backfill soil mass.
- D. Contractor shall submit reinforced fill sample and laboratory test results to the Architect/Engineer for approval, prior to the use of any proposed reinforced backfill material.

2.06 Geogrid Soil Reinforcement

- A. Geosynthetic reinforcement shall consist of geogrids manufactured for soil reinforcement applications and shall be manufactured from high tenacity polyester yarn or high density polyethylene. Polyester geogrid shall be made from high tenacity polyester filament yarn with a molecular weight exceeded 25,000 g/m and with a carboxyl end group value less than 30. Polyester geogrid shall be coated with an impregnated PVC coating that resists peeling, cracking and stripping.
- B. T_a – Long Term Allowable Tensile Design Load. T_a of the geogrid material shall be determined as follows: $T_a = T_{ult}/(RF_{cr} * RF_d * RF_{id} * FS)$. T_a shall be evaluated based on a 75 year design life.
1. T_{ult} – Short Term Ultimate Tensile Strength. T_{ult} shall be determined in accordance with ASTM D4595 or ASTM D6637. T_{ult} is based on the minimum average roll values (MARV).
 2. RF_{cr} – Reduction Factor for Long Term Tension Creep. RF_{cr} shall be determined from 10,000 hour creep testing performed in accordance with ASTM D5262. $RF_{cr} = 1.45$ minimum.
 3. RF_d – Reduction Factor for Durability. RF_d shall be determined from polymer specific durability testing covering the range of expected soil environments. $RF_d = 1.10$ minimum.

4. RFid – Reduction Factor for Installation Damage. RFid shall be determined from product specific construction damage testing performed in accordance with ASTM D5818. Test results shall be provided for each product to be used with project specific or more severe soil types. RFid = 1.05 minimum.
 5. FS – Overall Design Factor of Safety. FS shall be 1.5 unless noted for the maximum allowable working stress calculation.
- C. The maximum design tensile load of the geogrid shall not exceed the laboratory tested ultimate strength of the geogrid/facing unit connection divided by a factor of safety of 1.5. The connection strength testing and computation procedures shall be in accordance with ASTM D6638 Connection Strength between Geosynthetic Reinforcement and Segmental Concrete Units or NCMA SRWU-1.
- D. Ci – Coefficient of Soil Interaction. Ci values shall be determined per ASTM D6706 at a maximum 0.75 inch (19 mm) displacement.
- E. The geogrid manufacturer shall have a Manufacturing Quality Control program that includes QC testing by an independent laboratory. The QC testing shall include Tensile Strength testing, Melt Flow Index testing for HDPE geogrids and Molecular Weight testing for polyester geogrids.

2.07 Drainage Pipe

- A. Drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D3034 or corrugated HDPE pipe manufactured in accordance with AASHTO M252.

2.08 Geotextile Filter Fabric

- A. When required, geotextile filter fabric shall be a needle-punched nonwoven fabric that meets the requirements of AASHTO M288.

PART 3 - EXECUTION

3.01 Excavation

- A. Contractor shall excavate to the lines and grades shown on the construction drawings. The Owner and Contractor's QA/QC representative shall inspect the excavation and test the foundation soils and approve prior to placement of the leveling pad material or fill soils. Any over-excavation required to remove unsuitable soils shall be oversized from the front of the leveling pad and back of the geogrid reinforcement.

- B. Over-excavation and replacement of unsuitable soils and replacement with approved compacted fill will be compensated as agreed upon with the Owner.

3.02 Base Leveling Pad

- A. Leveling pad material shall be placed to the lines and grades shown on the construction drawings to a minimum thickness of 6 inches (150 mm) and extend laterally a minimum of 6 inches in front and behind the wall unit.
- B. Soil leveling pad materials shall be compacted to a minimum of 95% of Standard Proctor density per ASTM D697 or 92% Modified Proctor density per ASTM D1557.
- C. Leveling pad shall be prepared to insure full contact with the base surface of the concrete units.

3.03 Unit Installation

- A. First course of units shall be placed on the leveling pad at the appropriate line and grade. Alignment and level shall be checked in all directions and insure that all units are in full contact with the base and properly seated.
- B. Place the front of units side-by-side. Do not leave gaps between adjacent units. Layout of corners and curves shall be in accordance with manufacturer's recommendations.
- C. Install shear/connecting pins per manufacturer's recommendations.
- D. Place and compact drainage fill within and behind wall units. Place and compact reinforced backfill soil behind drainage fill.
- E. Maximum stacked vertical height of wall units, prior to drainage fill and backfill placement and compaction, shall not exceed two courses.

3.04 Structural Geogrid Installation

- A. Geogrid shall be installed with the highest strength direction perpendicular to the wall alignment.

- B. Geogrid reinforcement shall be placed at the strengths, lengths and elevations shown on the construction drawings, or as directed by the engineer.
- C. The geogrid shall be laid horizontally on compacted backfill and attached to the wall unit pins and within 1 inch of the face of the units. Place the next course of units over the geogrid. The geogrid shall be pulled taut and anchored prior to backfill placement on the geogrid.
- D. Geogrid reinforcements shall be continuous throughout their embedment lengths and placed side-by-side to provide 100% coverage at each level. Spliced connections between shorter pieces of geogrid or gaps greater than 2 inches between adjacent pieces of geogrid are not permitted.

3.05 Reinforced Backfill Placement

- A. Reinforced backfill shall be placed, spread and compacted in such a manner that minimizes the development of slack in the geogrid and installation damage to the geogrid.
- B. Reinforced backfill shall be placed and compacted in lifts not to exceed 6 inches (150 mm) where hand operated compaction equipment is used, or 8 – 10 inches (200 to 250 mm) where heavy compaction equipment is used. Lift thickness shall be decreased to achieve the required density, as needed.
- C. Reinforced backfill shall be compacted to a minimum of 95% of Standard Proctor density per ASTM D697 or 92% Modified Proctor density per ASTM D1557. The moisture content of the reinforced backfill material during compaction shall be uniformly distributed throughout each layer and shall be dry of optimum by 0 to 3 percentage points of moisture.
- D. Only hand operated compaction equipment shall be allowed within 3 feet (1 M) from the back of the concrete units.
- E. Tracked construction equipment shall not be operated directly upon the geogrid reinforcement. A minimum fill thickness of 6 inches (150 mm) is required prior to operation of tracked vehicles over the geogrid. Tracked vehicle turning should be kept to a minimum to prevent tracks from displacing the fill and damaging or displacing the units or geogrid.
- F. Rubber tired equipment may pass over geogrid reinforcement at slow speeds, less than 10 MPH. Sudden braking and turning shall be avoided.
- G. At the end of each day's operation, the Contractor shall slope the last lift of reinforced backfill away from the wall units to direct runoff away from the wall face.

The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

3.06 Cap Installation

- A. Prior to placement of the cap units, the upper surface of the top course of wall units shall be cleaned of soil and any other material.
- B. Cap units shall be adequately glued to the underlying wall units with an all-weather exterior construction adhesive.

3.07 As-built Construction Tolerances

- A. Vertical alignment: ± 1.5 inches (40 mm) over any 10 foot (3 m) distance.
- B. Wall batter: within 2 degrees of design batter. Overall wall batter shall be ≥ 0 degrees.
- C. Horizontal alignment: ± 1.5 inches (40 mm) over any 10 foot (3 m) distance.
- D. Corners and curves: ± 1 foot (300 mm) to theoretical location.
- E. Maximum horizontal gap between erected units shall be $\leq 1/2$ inch (13 mm).

3.08 Field Quality Control

- A. Quality Assurance – The owner shall engage a site geotechnical engineer to provide quality assurance and inspection/testing services during construction. This does not relieve the Contractor from performing the minimum construction quality control testing described in this specification.
- B. Quality assurance by owner's site geotechnical engineer shall include foundation soil inspection and testing and verification of the geotechnical design parameters including verification that the contractor's quality control testing is adequate as a minimum. Quality assurance shall also include observation of the construction for general compliance with the design drawings and project specifications.
CONTRACTOR IS RESPONSIBLE TO NOTIFY OWNER'S GEOTECHNICAL REPRESENTATIVE 3 DAYS IN ADVANCE OF ALL WORK ACTIVITIES RELATED TO WALL CONSTRUCTION. GEOTECHNICAL ENGINEER SHALL BE PRESENT AT ALL TIMES FOR OBSERVATION AND INSPECTION OF ALL WORK RELATED

TO THE WALL CONSTRUCTION UNLESS CONTRACTOR IS SPECIFICALLY
DIRECTED OTHERWISE BY OWNER OR OWNER'S FIELD REPRESENTATIVE.

- C. Quality Control – The Contractor shall engage independent inspection and testing services to perform the minimum quality control testing described in the retaining wall design plans and specifications. Only qualified and experienced technicians and engineers shall perform quality control testing and inspection services.
- D. Quality control testing shall include soil and backfill testing to verify soil types and strengths, compaction and moisture conditions and verification that the retaining wall is being constructed in accordance with the design plans and specifications.

END OF SECTION 323223

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SECTION 323300 – WALK, ROAD AND PARKING APPURTENANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work under this Section consists of, but is not limited to, the following:
 - 1. All permanent traffic control signage.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written certification that all materials comply with the specifications and with all regulatory bodies having jurisdiction on this work.
- B. Shop Drawings: Show sign layout and mounting details.

1.4 QUALITY ASSURANCE

- A. All permanent signage shall conform to the latest specifications of the Commonwealth of Pennsylvania, Department of Transportation (PennDOT).

PART 2 - PRODUCTS

2.1 TRAFFIC CONTROL SIGNS

- A. Manufacturers for Permanent Site Signage: All signage products shall be manufactured by firms authorized and acceptable to the Commonwealth of Pennsylvania, Department of Transportation (PennDOT).
- B. Aluminum sign blanks shall conform to ASTM B 209 Alloy 5052-H38. The sign faces shall be fabricated from materials conforming to PennDOT Specifications Publication No. 408, Section 931 and Section 1103. Each sign shall have three mounting holes.
 - 1. Obtain any permits and approvals required for this work.

2. Refer to contract drawings for extent of work for traffic control signage.

2.2 TRAFFIC CONTROL SIGN POSTS

- A. Steel Posts: Sign posts shall be breakaway steel in accordance with PennDOT Specification Publication No. 408, Section 1103.08 except as follows:
 1. The square anchor posts (36 inches long, sized to receive sign post) shall be 12 gauge and punched on four sides. The square sign posts (size as indicated on drawings) shall be 12 gauge with the length as necessary to accommodate the proper sign mounting height. The post shall have holes punched on all four sides.
 2. Color: Apply a green polyester coating in accordance with PennDOT Specifications Publication No. 408, Section 1103.08(c).
- B. The steel posts shall be certified by the manufacturer to conform to the breakaway requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs".

2.3 MISCELLANEOUS MATERIALS

- A. Fasteners and Anchorages: Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for bolts, nuts, and washers.
- B. Bolts: All bolts, nuts and washers shall be stainless steel, Type 304.

2.4 FINISH

- A. All parts of the permanent site signage shall have a fully sealed, 2 mil thick, oven baked polyester powder. Color shall be as selected by the Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All signs shall be mounted on square steel posts with stainless steel nuts, bolts, and washers. Place signs in accordance with PennDOT standards. Post mounted signs shall be secured with three (3) bolts.

3.2 PROTECTION

- A. Protect installed materials until date of Substantial Completion.

END OF SECTION 323300

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SECTION 329200 – LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Lawn seeded areas.
 - 2. Sodding.
 - 3. Soil amendments.
 - 4. Initial maintenance of seeded areas.
 - 5. All areas throughout the entire site which are disturbed by construction activities, shall be seeded.
- B. Related Sections include the following:
 - 1. Division 31 Section “Site Clearing” for topsoil stripping and stockpiling.
 - 2. Division 31 Section “Earthwork” for top soil, distribution, and fine grading.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Seed germination and purity tests will be furnished to the Architect for approval prior to applying seed. For each seed lot number, the Contractor will be required to furnish:
 - 1. State or country of origin.
 - 2. Lot number of the certified seed.
 - 3. Kind of seed and variety.
 - 4. Seed purity, germination, weed content, and inert matter.

5. Delivery slips to substantiate the quantities delivered to the site.
- C. Submit labeled samples of fertilizers and other applications showing mixture and composition of each specified.
- D. Certification of Sod: Written certification for sod complying with the specifications. Provide name and telephone number of sod supplier including seed mix.
- E. The Contractor shall provide and pay for topsoil testing. The testing agency shall be acceptable to the Architect. Provide test data for the following:
 1. pH factor.
 2. Mechanical analysis.
 3. Percentage of organic content.
 4. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply nutrients to a satisfactory level of planting.
- F. Maintenance Instructions: Provide (3) sets of instructions recommending procedures to be established by the Owner for maintenance of grass areas. Instructions shall be organized by calendar months for a one-year period.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn and meadow establishment.
 1. Installer's Field Supervision: Require installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Seed Quality Standards: All seed shall be fresh, clean, new crop seed delivered to the site in the original unopened containers. Seed shall be Gold Tag Certified by the state or country of origin.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed will be delivered to the site in the original, sealed and labeled and undamaged containers.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Material" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications for Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

- C. Fertilizers and other materials shall be delivered and stored in original unopened packages, kept dry and not opened until needed for use. Damaged or faulty packages shall not be used.

1.6 SITE CONDITIONS

- A. Utilities: All underground utility work shall be installed, inspected and approved before operations are started.
- B. Coordinate all seed work to avoid conflict and disturbance with other operations.

1.7 WARRANTY

- A. Grass and Sod Warranty: The Contractor shall warrant the condition of the lawn areas for one year from the date of Substantial Completion. This warranty shall include services by the Contractor, as required to maintain lawn areas and keep them free of weeds, fungus, insects and bare spots. The Contractor shall provide all labor and equipment necessary (normal wear and tear, mowing and watering is not included) except as hereinafter specified in Initial Maintenance.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Seed Mixture: As indicated on the drawings.
- B. Sod:
 - 1. Athletic Field Sod: Composed of turf type seed as follows:
 - a. 90 percent Hybrid Turf Type Tall Fescue consisting of three equal parts of the following varieties:

Aurora	Osprey	Titan 2
Duke	Genesis	Pixie
Montauk	Coyote	MB-22-92
Cross Fire II	Wareick	Lancer
 - b. The remaining 10 percent seed shall be hybrid Kentucky Bluegrass.
 - 2. Sod Pad Size: Uniform thickness of 3/8 inch, measured at time of cutting, excluding top growth and thatch. Provide in large rolls at suppliers size of uniform length and width with 5 percent allowable deviation in either length or width. Broken or torn rolls or rolls with uneven ends are not acceptable.

3. Sod Strength: Provide sod pads capable of supporting their own weight and retaining size and shape when pad is suspended vertically from a firm grasp on upper 10 percent of the pad.
- C. Lime: Lime shall be standard ground agricultural limestone not less than 50% lime oxides (calcium oxide and magnesium oxide), 98% of which will pass a twenty (20) mesh sieve: 40% of which will pass a one hundred (100) mesh sieve.
- D. Fertilizers: All fertilizers shall be uniform in composition, free flowing and suitable for application with approved equipment, delivered to the site in original bags or cartons and fully labeled in conformance with applicable state fertilizer laws bearing the name, trade name or trademark and warranty of the producer.
 1. Contractor shall review topsoil analysis and provide fertilizer with recommended quantities of nitrogen, phosphorus and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
- E. Straw Mulch: Wheat or oat straw, free of viable seed, well cured to less than 20% moisture content by weight.
- F. Mulch Binder: Either water soluble natural vegetable gum blended with gelling and hardening agents or a water-soluble blend of hydrophilic polymers, viscosifiers, sticking aids and gums.
- G. Pre-Emergent Weed Control: “Tupersan” manufactured by DuPont, or approved equal.
- H. Post-Emergent Broadleaf Herbicide: “Confront” and “Banvil” manufactured by Dow AgroServices or approved equal.
- I. Non-Selective Herbicide: “Round-Up” manufactured by Monsanto Company or approved equal.
- J. Organic Amendments:
 1. Compost is a widely used bulk organic soil amendment and a recycled product. Because it is applied at much greater rates than fertilizer, compost has a significant cumulative effect on nutrient availability and may reduce or eliminate initial fertilization. Consider each plant’s pH and soluble salt requirements and how they relate to the compost being used and the resulting soil-compost mix.
 2. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - a. Organic Matter Content: 50 to 60 percent of dry weight.

- b. Feedstock: Agricultural, food, or industrial residuals, biosolids, yard trimmings NOT PERMITTED.
- c. Leaf Mold: Double ground, aged leaf matter.
- d. Spent Mushroom Substrate: Composted, sterilized spent mushroom soil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydro seeding and hydro mulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 FINISH GRADE PREPARATION

- A. Any stones larger than 2 inches in any dimension shall be removed from the top 3 inches utilizing a mechanical rock picker.
- B. Final grading shall be accomplished utilizing a LASER ASSISTED hydraulic land plane attached to a flotation tired agricultural tractor.
- C. Cultivate and restructure the topsoil to a depth of 3-4 inches. Grade tolerance shall be held to 1/2 inch per foot.
- D. Final stone pick the surface of any stones larger than 1 inch in any dimension.

3.4 SOIL STRUCTURING

- A. After the topsoil for grass and sod is prepared and graded to the proper elevations, the following materials shall be applied and tilled (mixed) into the full depth of the topsoil taking care not to disturb the subsoil.
 - 1. Amendments shall be added at rates and concentrations recommended by the top soil analysis provided by the Contractor.
 - 2. Incorporate 3 Cu. Yd. organic matter (1-inch layer) per 1,000 sq. ft. into top 6-inches of top soil.
- B. After incorporation of the above materials, the topsoil shall be refirmed by dry-rolling (topsoil moisture content must be near zero percent) with a five (5) ton roller on a dual flotation tired agricultural tractor.

3.5 SEEDING

- A. Seeding will not be permitted until final precision grading is reviewed by the Architect.
- B. Seeding shall be done between the dates indicated on the plans.
- C. Seed during favorable weather conditions.
- D. Seed using a manually-propelled or power-drawn hopper devices. Uniformly distribute the seed by sowing half the seed in one direction and the remainder at right angles to the direction of the first sowing. Cover seed an average depth of 1/4 inch by means of chain harrow, cultipacker, or other approved method.
- E. Hydro seeding will be permitted on steep slopes only with approval of the Architect.

3.6 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy. Mist topsoil surface with water immediately prior to laying sod to form a "glue."
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Lightly tamp sod to ensure good soil contact. Do not roll sod. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.
- D. Install sod a minimum of 4 weeks prior to athletic play or use.

3.7 MAINTENANCE AND ESTABLISHMENT

- A. Mowing: The Contractor shall mow all areas 6 times at a height of 2-1/2 inches to 3 inches and be responsible for establishing an acceptable stand of grass. Do not mow grass to less than 2.5 inches.
- B. Establishment Acceptance: An acceptable stand of grass means the existence of a minimum of 72 viable turf plants per square foot and no bare spot shall exceed a 2 inch by 2 inch area. At the time of final inspection, all areas achieving this criteria will be accepted as completed and only those specific areas not meeting this criteria will continue to receive maintenance until the criteria is met.
- C. Maintain areas by watering, weeding, mowing, trimming, and other operations such as rolling, regrading, replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas.
- D. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water lawn with a fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- E. Mow lawns as soon as there is enough top growth to cut with mower set at specified height of 2.5 to 3 inches for principal species planted. Repeat mowing as required to maintain specified height. Remove no more than 40 percent of grass leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Time initial and subsequent mowings to maintain grass height as heretofore specified. Capture and remove cuttings from lawn areas and properly dispose of off-site.
- F. At the end of the planting season apply insoluble 60% nitrogen fertilizer at the rate of 4.5 lbs/1000 square feet.
- G. The following Spring apply an application of pre-emergence weed control at the manufacturer's recommended rate and an application of insoluble 60% nitrogen fertilizer at the rate of 4.5 lbs/1000 square feet.
- H. Prior to June 1st, apply an application of broad leaf herbicide at the manufacturer's recommended rate and an application of insoluble 60% nitrogen fertilizer at the rate of 4.5 lbs/1000 square feet.

3.8 ACCEPTANCE

- A. When work and initial maintenance and establishment is substantially completed Architect will, upon request, make an inspection to determine acceptability.
 - 1. Grass work may be inspected for acceptance in parts agreeable to Architect, provided work offered for inspection is complete, including maintenance.
- B. Replant rejected work and continue specified maintenance until re-inspected by Architect and found to be acceptable.
- C. Seeded and sodded lawns will be acceptable provided requirements, including maintenance, have been met and healthy, well-rooted, even-colored, viable lawn is established, free of weeds, open joints, bare areas, and surface irregularities.

3.9 CLEANUP

- A. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after lawn is established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 – EXTERIOR PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Trees.
 - 2. Shrubs.
 - 3. Soil amendments.
 - 4. Mulch.
 - 5. Providing imported top soil as required.
 - 6. Initial maintenance of landscape materials.
- B. Related Sections include the following:
 - 1. Division 31 Section "Site Clearing" for protection of existing trees, topsoil stripping and stockpiling.
 - 2. Division 31 Section "Earthwork" for excavation, filling and rough grading.
 - 3. Division 32 Section "Lawns and Grasses" for lawn planting.

1.3 SUBMITTALS

- A. Plant and Material Certifications: Manufacturer's or vendor's certified analysis of soil amendments and fertilizer materials.
- B. Soil Tests: Contractor shall sample a minimum of (3) topsoil areas; submit for soil testing and report findings to Architect for review. Test reports shall provide recommendations for soil amendments.

- C. Photographs: Provide photographs of typical of each tree and shrub species for Architect's review prior to shipping. Material furnished to the site shall conform to the proposed photographed specimens.
- D. Organic Matter: Provide a one pound sample of organic matter along with manufacturer's product analysis for Architect's review.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of landscape work for one full year. Recommendations shall be organized by month and provide sufficient information explaining each task and required materials/labor. Submit before expiration of required maintenance period(s).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants on projects of similar or larger scope.
 - 1. Field Supervision: Require installer to maintain an experienced full-time supervisor on project site when planting is in progress.
- B. Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials. Provide nursery tags on plant material to certify plant species comply with the plant list.
- C. Do not make substitutions. If specified landscape material is not obtainable, submit proof of non-availability to Architect, together with proposal for use of equivalent material.
- D. Trees and Shrubs: Provide trees and shrubs, of quantity, size, genus, species, and variety shown and scheduled for landscape work and complying with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock". Provide healthy, vigorous stock, grown in recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae, and defects such as knots, sun-scald, injuries, abrasions, or disfigurement.
 - 1. Where formal arrangements or consecutive order of trees or shrubs are shown, select stock for uniform height and spread, and label with number to assure symmetry in planting.
- E. Top Soil: Existing top soil will be stripped and stockpiled as specified in Division 31 Section "Site Clearing". In the event there is a shortage of top soil to complete the work specified then the Contractor shall import top soil at his expense. Quality of imported top soil shall be as specified in Division 31 Section "Earthwork".

1. In the event there is a surplus of top soil then the Contractor shall deposit and spread the top soil where directed by the Architect. Excess top soil shall not be removed from the site without authorization from the Owner.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.
- B. Trees and Shrubs: Provide freshly dug trees and shrubs. Do not prune prior to delivery unless otherwise approved by Architect. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches, or destroy natural shape. Provide protective covering during delivery. Do not drop balled and burlapped stock during delivery.

1.6 JOB CONDITIONS

- A. Planting shall be done within the following dates unless otherwise noted: September 15 to November 15 and March 15 to May 15. The Owner and landscape subcontractor may agree, in writing, to planting outside of these dates.
- B. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to Architect. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.7 WARRANTY

- A. Warrant trees and shrubs, for a period of 18 months after date of Substantial Completion, against defects including death and unsatisfactory growth.
- B. During the warranty period, should the Contractor find maintenance of the landscape detrimental to the health or growth of the plant material, the Contractor shall notify the Owner and Architect, in writing, the found condition and a recommended action to correct the matter. If such notification is not provided to the Owner and Architect, the Contractor shall be responsible to replace any and all dead or unhealthy material.
- C. Remove and replace trees, shrubs, or other plants found to be dead or in unhealthy condition during warranty period. Make replacements during growth season following end of warranty period. Replace trees and shrubs which are in doubtful condition at end of warranty period; unless, in opinion of Architect, it is advisable to extend warranty period for a full growing season.

- D. Contractor shall notify Owner in writing fourteen calendar days prior to the expiration of the warranty period to arrange for a final inspection by all parties involved.

PART 2 - PRODUCTS

2.1 SOIL AMENDMENTS

- A. Lime: Natural dolomitic limestone containing not less than 85 percent of total carbonates with a minimum of 30 percent magnesium carbonates, ground so that not less than 90 percent passes a 10-mesh sieve and not less than 50 percent passes a 100-mesh sieve.
- B. Organic Matter:
1. Leaf mold composted sufficiently to break down all woody fibers and leaf structures, and free of toxic and non-toxic matter shall be commercially prepared.
 2. Spent mushroom substrate, commercially prepared, composted and sterilized.
- C. Mulch: Organic mulch free from deleterious materials, noxious weed seeds and insect life and suitable for top dressing of trees, shrubs, or plants and consisting of the following:
1. Double shredded, aged hardwoods, not decomposed.
- D. Commercial Fertilizer: Complete fertilizer of neutral character, with some elements derived from organic sources and containing following percentages of available plant nutrients:
1. For trees and shrubs, provide fertilizer with not less than 5 percent total nitrogen, 10 percent available phosphoric acid and 5 percent soluble potash.
 2. Licorice root or ground corn cobs.
- E. Hydrogel: Non-toxic, super absorbent, sodium-free, hydrogel material that absorbs up to 200 times its weight in water.
1. Product: Terra Sorb; Plant Health Care, Inc. or approved equal.

2.2 PLANT MATERIALS

- A. Quality: Provide trees, shrubs, and other plants of size, genus, species, and variety shown on the Contract Drawings and scheduled for landscape work; complying with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock" and "Hortus Third".
- B. Deciduous Trees: Provide trees of height and caliper scheduled or shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed.
 - 1. Provide balled and burlapped (B&B) deciduous trees. All burlap and twine shall be biodegradable.
- C. Deciduous Shrubs: Provide shrubs of the height or spread shown or listed and with not less than minimum number of canes required by ANSI Z60.1 for type and height of shrub required.
 - 1. Provide balled and burlapped (B&B) or container grown deciduous shrubs as indicated in the planting schedule. All burlap and twine shall be biodegradable.
- D. Coniferous and Broadleafed Evergreens: Provide evergreens of sizes shown or listed. Dimensions indicate minimum spread for spreading and semi-spreading type evergreens and height for other types, such as globe, dwarf, cone, pyramidal, broad upright, and columnar. Provide normal quality evergreens with well balanced form complying with requirements for other size relationships to the primary dimension shown.
 - 1. Provide balled and burlapped (B&B) or container grown evergreen trees or shrubs as indicated in the planting schedule. All burlap and twine shall be biodegradable.

2.3 MISCELLANEOUS LANDSCAPE MATERIALS

- A. Stakes and Guys: Provide stakes and deadmen of sound new hardwood, treated softwood, or redwood, free of knot holes and other defects. Provide wire ties and guys of 2-strand, twisted, pliable galvanized iron wire, not lighter than 12 ga. with zinc-coated turnbuckles. Provide not less than 1/2 inch diameter rubber or plastic hose, cut to required lengths and of uniform color, material, and size to protect tree trunks from damage by wires. Stakes and guys shall be removed at the end of the 18 month warranty period by the Contractor.
- B. Landscape Fabric: Nonwoven polyester, water permeable, weed suppressant, filtration fabric weighing not less than 3 ounces per square yard.
 - 1. Product: Mirascape; Mirafi, Inc., or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas and secure Architect's acceptance before start of planting work. Make minor adjustments as may be required.

3.3 PREPARATION OF PLANTING SOIL

- A. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
- B. Mix specified soil amendments and fertilizers with topsoil at rates specified per soil test results. Also add 20% by volume organic matter and hydrogel per manufacturer's written instructions. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.
- C. Planting soil for trees and shrubs shall consist of one part organic matter to 3 parts top soil uniformly mixed.
- D. Planting soil for trees and shrubs requiring acid soil shall consist of four parts organic matter to six parts top soil uniformly mixed.
- E. Mix fertilizer into planting soil at the rate of 0.25 pounds per cubic foot of soil or per rates specified by soil test results.

3.4 PREPARATION OF PLANTING BEDS

- A. Loosen subgrade of planting bed areas to a minimum depth of 12 inches using a culti-mulcher or similar equipment. Remove stones measuring over 1-1/2 inches in any dimension. Remove sticks, stones, rubbish, and other extraneous matter.
- B. Spread planting soil mixture to minimum depth required to meet lines, grades, and elevations shown, after light rolling and natural settlement. Place approximately 1/2 of total amount of planting soil required. Work into top of loosened subgrade to create a transition layer, then place remainder of the planting soil.
- C. Dig beds not less than 12 inches deep and mix with specified soil amendments and fertilizers.
- D. Bermed (raised) planting beds shall be formed of all top soil from top of the plant down to the level of adjoining seeded areas.

3.5 EXCAVATION FOR TREES AND SHRUBS

- A. Excavate pits, beds, and trenches with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation.
 - 1. For trees, make excavations a minimum of 12 inches wider on each side than as the ball diameter and equal to the ball depth, plus following allowance for setting of ball on a layer of compacted backfill:
 - a. Allow for 3 inch thick setting layer of planting soil mixture.
 - 2. For shrubs make excavation a minimum of 6 inches wider on each side than the ball diameter plus an allowance of 3 inches for setting of ball on a layer of compacted backfill.
- B. Dispose of subsoil removed from planting excavations. Do not mix with planting soil or use as backfill.

3.6 PLANTING TREES AND SHRUBS

- A. Set balled and burlapped (B&B) stock on layer of compacted planting soil mixture, plumb and in center of pit or trench with top of ball at same elevation as it was before transplanting. Remove burlap from top half of balls; retain on bottoms. Remove all twine entirely from plant root ball. When set, place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.
- B. Dish top of backfill to allow for mulching.

- C. Install landscape fabric on planting beds, in accordance with the manufacturer's specifications with all joints lapped.
- D. Mulch pits, trenches, and planted areas. Provide not less than following thickness of mulch, and work onto top of backfill and finish level with adjacent finish grades.
 - 1. Provide 4 inch minimum, and 6 inch maximum thickness of mulch as top dressing. Dish top surface of the mulching to form a 4 inch high temporary "saucer" around each tree and shrub.
- E. Unless directed by the Architect, do not prune, thin out, or shape trees and shrubs.
- F. Remove and replace excessively pruned or misformed stock resulting from improper pruning.
- G. If directed by the Architect, guy and stake trees immediately after planting, with a minimum of 3 guys and stakes per tree, spaced at 120° intervals as per details on the drawings.
- H. If directed by the Architect, provide tree wrap on deciduous trees as indicated on the drawings.

3.7 MAINTENANCE

- A. Begin maintenance immediately after planting.
- B. Maintain trees and shrubs not less than 60 days after the Date of Substantial Completion.
- C. Maintain trees and shrubs by pruning, cultivating, watering, and weeding as required for healthy growth. Restore planting saucers. Tighten and repair stake and guy supports and reset trees and shrubs to proper grades or vertical position as required. Spray as required to keep trees and shrubs free of insects and disease.
- D. Contractor shall make all necessary provisions, at his expense, for watering of all landscaping work.

3.8 CLEANUP AND PROTECTION

- A. During landscape work, keep pavements clean and work area in an orderly condition.

- B. Contractor shall be responsible for removing all trash and debris from the site daily. Site paving and curbs shall be broom cleaned and power washed at completion of all landscape work.
- C. All removed trash and debris shall be legally disposed of, off-site by the Contractor.
- D. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.9 INSPECTION AND ACCEPTANCE

- A. When landscape work is completed, including maintenance, Architect will, upon request, make an inspection to determine acceptability.
 - 1. Landscape work may be inspected for acceptance in portions as agreeable to Architect, provided each portion of work offered for inspection is complete, including maintenance.
- B. When inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until reinspected by Architect and found to be acceptable. Remove rejected plants and materials promptly from project site.

END OF SECTION 329300

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SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Identification devices.
 - 6. Grout.
 - 7. Piped utility demolition.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Concrete bases.
 - 10. Metal supports and anchorages.

1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 JOINING MATERIALS

- A. Refer to individual Division 33 piping Sections for special joining materials not listed below.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

- E. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- F. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- G. Brazing Filler Metals: AWS A5.8, BCuP Series, or BAg1, unless otherwise indicated.
- H. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- I. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- J. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

2.2 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.3 SLEEVES

- A. Mechanical sleeve seals for pipe penetrations are specified in Division 23 Section "Basic Mechanical Materials and Methods."
- B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.4 IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
 - 2. Location: Accessible and visible.
- B. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.
 - 1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
 - 2. Color: Comply with ASME A13.1, unless otherwise indicated.

- C. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.
1. Material: 0.032-inch- thick, polished brass or aluminum.
 2. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

2.5 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 33 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.

- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - a. PVC Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
- J. Verify final equipment locations for roughing-in.
- K. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 33 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment level and plumb, unless otherwise indicated.
- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- C. Install equipment to allow right of way to piping systems installed at required slope.

3.5 IDENTIFICATION

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
 - 1. Locate pipe markers on exposed piping according to the following:
 - a. Near each valve and control device.
 - b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
 - c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
 - d. At manholes and similar access points that permit view of concealed piping.

- e. Near major equipment items and other points of origination and termination.
- B. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete".

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 330500

SECTION 332200 - WATER MAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Water Distribution Lines and Fittings.
 - 2. Domestic water lines and fire service main.
 - 3. Provide all mains indicated on the Civil drawings up to 5'-0" from exterior face of the building. Contractor shall be responsible for the final connection to the building. Coordinate with the Plumbing Contractor.
 - 4. Obtain and pay for all permits and inspections required for the work under this Section.
 - 5. Restoration of lawn, paving, etc. caused by the installation of water mains and associated structures.
- B. Related Sections include the following:
 - 1. Division 3 Section "Concrete Work for Utilities."
 - 2. Division 31 Section "Excavation, Backfill and Compaction of Utilities."
 - 3. Division 33 Section "Water Main Valves."
 - 4. Division 33 Section "Testing and Disinfecting of Water Mains."

1.3 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
 - 1. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
- B. American Water Works Association (AWWA):
 - 1. AWWA C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. AWWA C110 Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48- inch, for Water and Other Liquids.
3. AWWA C111 Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
4. AWWA C150 Thickness Design of Ductile-Iron Pipe.
5. AWWA C151 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
6. AWWA C153 Ductile-Iron Compact Fittings, 3-inch through 16-inch, for Water and Other Liquids.
7. ASTM B 88: Specification for Seamless Copper Water Tube.
8. AWWA C900 polyvinyl chloride (PVC) pressure pipe and fabricated fittings, 4 inches through 12 inches.
9. AWWA M23 PVC pipe – design and installation.

C. Local water authority standards and specifications.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated including, but not limited to, the following:
 1. Pipe and pipe fittings.
 2. Joints and gaskets.
 3. Couplings.
 4. Adapters.
- B. Certification: Manufacturer's certificate certifying that the following items were manufactured and tested in accordance with the applicable standards:
 1. Pipe and pipe fittings.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with standards of authorities having jurisdiction for potable and fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

- C. Reject materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner, or acid solder.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling:

1. Do not place materials on private property without written permission of the property owner.
2. During loading, transporting and unloading, exercise care to prevent damage to materials.
3. Do not drop pipe or fittings. Avoid shock or damage at all times.
4. Take measures (i.e., use padded slings, hooks and tongs) to prevent damage to the exterior surface or internal lining of the pipe.

B. Storage:

1. Pipe may be strung along alignment where approved by the Architect.
2. Do not stack pipe higher than maximum stacking heights shown in AWWA C600 or as recommended by the pipe manufacturer.
3. Keep interior of pipe and fittings free from dirt or other foreign matter.
4. Store gaskets for mechanical and push-on joints in a cool, dry location out of direct sunlight and not in contact with petroleum products.

1.7 COORDINATION

- A. Coordinate connection to main water service with utility company.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 1. Atlantic States Cast Iron Pipe Company.
 2. United States Pipe and Foundry Company.
 3. Griffin Pipe Products Company

2.2 DUCTILE IRON PIPE

- A. Pipe: Comply with AWWA C151 and AWWA C150 requirements.
 - 1. Wall Thickness: Class 52 except as may be required for flanged pipe or restrained joints, use Class 53.
 - 2. Cement Mortar Linings: Conforming to AWWA C104, except the thickness of linings should not be less than the following:
 - a. 3 inches through 12 inches: 1/8 inch.
 - b. 14 inches through 24 inches: 3/16 inch.
- B. Fittings: Gray iron or ductile iron AWWA C110 or ductile iron compact fittings AWWA C153. All fittings shall have a minimum pressure rating of 250 psi and shall have cement lining and joints as required for pipe restraint.
- C. Joints: Push-on type or mechanical joint type in accordance with AWWA C111 for all pipe except at changes in alignment, valves or other conditions requiring pipe restraint.
 - 1. Rubber gaskets, lubricants, glands, bolts and nuts: AWWA C111.

2.3 PVC PIPE AND FITTINGS

- A. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray- iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 - b. Restraint: Megalugs.

2.4 JOINING MATERIALS

- A. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise noted.

2.5 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

2.6 PIPING SPECIALTIES

- A. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and corrosion as approved by the Architect.

2.7 THRUST RESTRAINT

- A. Provide thrust restraint in accordance with methods outlined. Length of restraint as scheduled on drawings.
 - 1. Concrete Thrust Blocks and Tie Rods: Details as shown on drawings. Concrete shall comply with PADOT Publication 408, Section 704, Type C (3,300 psi compressive strength at 28 days). Tie rods shall be constructed of suitable metal. Metal harness of tie rods shall be galvanized or otherwise rust proofed and shall be painted with bituminous coating after installation.
 - 2. Megalug Retainer Glands: Mechanical joint restraint consisting of follower gland which when actuated imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. ASTM A 536-80 ductile iron follower gland of dimensions such that it can be used with AWWA C153 mechanical joints. Restraining devices shall be of ductile iron, heat treated to a minimum hardness of 370 BHN. Twist-off nuts shall be used to insure proper actuating of the restraint device. Restraint device shall have a 250 psi minimum working pressure with 2:1 minimum safety factor. Megalug retainer gland equivalent to EBAA Iron, Inc.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform trench excavation to the alignment indicated on the Drawings.
- B. Unless otherwise indicated on the Drawings, provide for a minimum cover of 48 inches above the top of piping laid in the trench based on the finished grade elevation.
- C. Provide pipe bedding as specified and as shown on the drawings for PVC pipe. Place aggregate in a manner to avoid segregation, and compact to the maximum practical density so that the pipe can be adequately supported.

3.2 LAYING PIPE IN TRENCHES

- A. Give ample notice to the Architect in advance of pipe laying operations.
- B. Clean and inspect each length of pipe or fitting before lowering into the trench. Do not lower pipe into the trench except that which is to be immediately installed.

- C. Lower pipe into trench using handling equipment designed for the purpose to assure safety of personnel and to avoid damage to pipe. Do not drop pipe.
- D. Lay pipe with bell pointing toward the direction of construction (up grade).
- E. Lay pipe to a uniform line with the barrel of the pipe resting solidly in bedding material throughout its length. Excavate recesses in bedding material to accommodate joints, fittings and appurtenances. Do not subject pipe to a blow or shock to achieve solid bearing or grade.
- F. Lay each section of pipe in such a manner as to form a close concentric joint with the adjoining section and to avoid offsets.
- G. Lubricate pipe and gaskets as recommended by the manufacturer. Assemble to provide tight, flexible joints that permit movement caused by expansion, contraction, and ground movement. If unusual joining resistance is encountered or if the pipe cannot be fully inserted into the bell, disassemble joint, inspect for damage, reclean joint components, and reassemble joint.
- H. Install PVC AWWA pipe according to ASTM F645 and AWWA M23.
- I. Assemble joints in accordance with recommendations of the manufacturer.
 - 1. Push-on Joints:
 - a. Clean the inside of the bell and the outside of the spigot. Insert rubber gasket into the bell recess.
 - b. Apply a thin film of gasket lubricant to either the inside of the gasket or the spigot end of the pipe, or both.
 - c. Insert the spigot end of the pipe into the socket using care to keep the joint from contacting the ground. Complete the joint by forcing the plain end to the bottom of the socket. Mark pipe that is not furnished with a depth mark before assembly to assure that the spigot is fully inserted.
 - 2. Mechanical Joints:
 - a. Wash the socket and plain end. Apply a thin film of soapy water. Slip the gland and gasket over the plain end of the pipe. Apply soapy water to gasket.
 - b. Insert the plain end of the pipe into the socket and seat the gasket evenly in the socket.
 - c. Slide the gland into position, insert bolts, and finger-tighten nuts.
 - d. Bring bolts to uniform tightness. Tighten bolts 180-degrees apart, alternately.

- e. Coat all bolts and nuts with bitumastic paint after installation.
- 3. Coupled Joints: In accordance with manufacturer's recommendations.
- 4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joint with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D3139 and pipe manufacturer's written instructions.
- 5. Dissimilar Materials Piping Joints: Use adaptors compatible with both piping materials, with O.D. and with system working pressure.
- J. Disassemble and remake improperly assembled joints using a new gasket.
- K. Check each pipe installed as to alignment in place. Correct deviations immediately. A deviation from the alignment as shown on the Drawings, or unnecessary deflection of pipe joints, will be cause for rejection.
- L. Place sufficient compacted embedment material on each section of pipe, as it is laid, to hold firmly in place.
- M. Install fittings and valves as pipe laying progresses. Do not support weight of fittings and valves from pipe.
- N. Install service connections as specified by the manufacturer.
- O. When the work is not in progress, and at the end of each work day, securely plug open ends of pipe and fittings to prevent trench water, earth, or other substances from entering the pipes or fittings.

3.3 CUTTING PIPE

- A. Cut pipe without damaging pipe or lining.
- B. Grind cut ends and rough edges smooth. Bevel end for push-on joints.

3.4 DEFLECTION

- A. When it is necessary to deflect a water main from a straight alignment horizontally or vertically, the water main shall be laid in a smooth arc and the deflection of joints shall not exceed the following limits:

1. Ductile Iron Pipe:

Laying Length	Max. Deflection - Inches Per Length 3" Through 12" Diameter
12 feet	12.5
16 feet	17
18 feet	19
20 feet	21

- B. Where required, fittings will be used to obtain deflections greater than noted above.

3.5 THRUST RESTRAINT

- A. Provide all tees, bends, caps, and plugs with concrete thrust blocks as indicated on the Drawings. Pour concrete thrust blocks against undisturbed earth. Locate thrust blocks to contain the resultant force and so pipe and fitting joints will be accessible for repair.
- B. Furnish and install, tie rods, clamps, set screw retainer glands, megalug retainer glands, or restrained joints as indicated on the Drawings and in accordance with the manufacturer's instructions.

3.6 CONCRETE ENCASEMENT

- A. Provide concrete encasement for pipeline where indicated on the Drawings.

3.7 CAST-IN-PLACE CONCRETE CONSTRUCTION

- A. Conform to the applicable requirements of Section 033020 "Concrete Work for Utilities".

3.8 CONNECTIONS

- A. For connecting pipe of different materials, use transition fittings and dielectric fittings as recommended by the manufacturer and approved by Architect.

3.9 COMPLETION

- A. Test and disinfect all water mains, valves, hydrants, etc. and accessories as specified in Section 332300.

END OF SECTION 332200

SECTION 332210 – WATER MAIN VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Water Main Valves.
 - 2. Valve Boxes.
- B. Related Sections include the following:
 - 1. Division 31 Section “Excavation, Backfill and Compaction of Utilities.”
 - 2. Division 33 Section “Water Mains.”
 - 3. Division 33 Section “Testing and Disinfecting Water Mains.”

1.3 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
 - 1. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
- B. American Water Works Associations (AWWA):
 - 1. AWWA C509 Resilient-Seated Gate Valves for Water and Sewerage Systems.
- C. Local water authority standards and specifications.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Submit manufacturer's descriptive literature for gate valves and valve boxes.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Prepare valves and accessories for shipment according to AWWA Standards and the following:
 - 1. Seal valve ends to prevent entry of foreign matter into product body.
 - 2. Box, crate, completely enclose, and protect products from accumulations of foreign matter.
- B. Store products in areas protected from weather, moisture, or possible damage.
- C. Do not store products directly on ground.
- D. Handle products to prevent damage to interior or exterior surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 GATE VALVES

- A. Iron body, bronze trim conforming to AWWA C509.
 - 1. Resilient seat of Styrene Butadiene SBR or Urethane Rubber bonded to cast iron wedge.
 - 2. Non-rising stem; O-ring stem seals.
 - 3. Provide 2-inch square operating nut; open counterclockwise unless otherwise indicated. Contractor shall supply valve wrench to Owner.
 - 4. Exterior shall be asphalt varnish or epoxy coated; interior ferrous metal parts shall be epoxy coated. Comply AWWA C550 requirements.
 - 5. Product: Metroseal 250; U.S. Pipe and Foundry Co.

2.3 VALVE BOXES

- A. Valve Boxes: Comply with AWWA M44 for cast-iron, 3-piece screw type valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER", and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
 - 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buries valve, and socket matching valve operating nut.
 - 2. Product: Model #4906; Bingham and Taylor Co.

2.4 TAPPING SLEEVE VALVE

- A. Conform to requirements of Gate Valve, except as noted below.
 - 1. Tapping sleeve valve shall have one end flanged to attach to tapping sleeve and other end mechanical joint with a special flange to permit attachment of drilling machine and adapter.
 - 2. Flanged end to comply with ANSI B16.1, Class 125.
 - 3. Product: Model T-9; U.S. Pipe and Foundry Co.

PART 3 - EXECUTION

3.1 GENERAL

- A. Determine the exact location, size, and construction details of valves from the Drawings. Obtain all necessary clarification and directions from Architect prior to the execution of work.
- B. Install in pipe in accordance with Division 33 Section "Water Mains" and as shown on the applicable details on the Drawings.
- C. Provide solid concrete masonry units and brick masonry units for support and encasement.

3.2 GATE VALVES

- A. Gate valves shall be installed in accordance with Section A.5 of AWWA C509 and the manufacturer's printed instructions.
- B. Install valves in conjunction with pipe laying. Set valves plumb.
- C. Provide buried valves with valve boxes installed flush with finished grade.

END OF SECTION 332210

SECTION 332300 – TESTING AND DISINFECTING WATER MAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Testing Water Main Pipeline (Domestic and Fire Protection):
 - a. Hydrostatic pressure testing.
 - b. Leakage testing.
 - 2. Disinfecting: Bacteriological testing.
 - 3. Test and disinfect all new water lines and accessories prior to the date of Substantial Completion.
- B. Related Sections include the following:
 - 1. Division 33 Section “Water Mains.”

1.3 REFERENCE STANDARDS

- A. American Water Works Association (AWWA):
 - 1. AAWA C600 Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances, Section 4.
 - 2. AAWA C651 Standard for Disinfecting Water Mains.
- B. Local water authority standards and specifications.

1.4 SUBMITTALS

- A. Test Procedures: Submit a testing sequence schedule including a list of testing equipment to be used.

B. Certification: Prior to start of testing, submit certification attesting that the
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pressure gauges to be used have been calibrated and are accurate to the degree specified in Part 2, Products.

1. Submit certification attesting that the chlorine form composition is as specified.
- C. Test Reports: Submit three copies of laboratory test reports of each bacteriological test.

1.5 QUALITY ASSURANCE

- A. Testing Agency: Bacteriological testing shall be performed by a certified testing laboratory engaged and paid for by the Contractor.
- B. Test Acceptance:
1. The Architect shall be advised in advance when tests and disinfection of the completed water main are to be performed.
 2. No test will be accepted until the results are below the specified maximum limits.
 3. The Contractor shall, at his own expense, determine and correct the sources of leakage and retest until successful test results are achieved.

PART 2 - PRODUCTS

2.1 HYDROSTATIC TEST EQUIPMENT

- A. Water pump.
- B. Pressure hose.
- C. Test connections.
- D. Water meter.
- E. Pressure gauge, calibrated to 0.1 lbs./sq. in.
- F. Pressure relief valve.
- G. All other equipment and accessories as required.

2.2 DISINFECTING CHEMICALS

- A. Liquid chlorine, calcium hypochlorite, or sodium hypochlorite conforming to AWWA Standards B300 and B301.

PART 3 - EXECUTION

3.1

PREPARATION

- A. Provide the water line under test with reaction thrust blocking. Hydrostatic testing shall not begin until the concrete thrust blocking has set. Allow 2000 psi 28-day strength concrete to set (cure) for a minimum of 7 days prior to testing. If high early strength 3,000 psi 3-day strength concrete is used, hydrostatic testing may not begin until the concrete has set a minimum of 2 days.
- B. Provide pumps, piping, tanks, connections, polyurethane plugs, and appurtenances at no additional expense to Owner. Obtain the necessary water from the temporary or permanent water supply.
- C. Preliminary Flushing:
 - 1. Prior to testing and disinfecting, except when the tablet chlorination method is used, fill the line to eliminate air pockets and flush the line at a rate of flow of 2.5 feet per second to remove particulates. Refer to AWWA C651 for rate of flow to produce 2.5 fps in pipe of various sizes.
 - 2. Dispose of flushing water as directed by the Architect at the Contractor's expense.

3.2 TESTING WATER LINES

- A. General: Each water line segment between valves shall be independently tested.
- B. Hydrostatic Testing:
 - 1. Test each newly installed section of water line by hydrostatic test procedure in accordance with the recommended practice established by AWWA, Standard C600, Section 4.
 - 2. Conduct pressure tests for a period of not less than 120 minutes at a pressure of not less than 1.5 times the working pressure or 150 psi whichever is greater based upon the elevation of the lowest point in the line under test corrected to the elevation of the test gauge. Obtain working pressure from Architect.
 - 3. Slowly fill the section to be tested with water, expelling air from the pipeline at the high points. Install corporation stops at high points if necessary. After all air is expelled, close air vents and corporation stops and raise the pressure to the specified test pressure.
 - 4. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest as required.

5. Allow a minimum of 5 days after installation of any thrust blocking before testing.

C. Leakage Tests:

1. After completion of successful pressure testing, conduct the leakage test for a 4-hour period at a test pressure of not less than 1.25 times the working pressure or 100 psi, whichever is greater, based upon the elevation of the highest point in the line under test corrected to the elevation of the test gauge.
2. Expel air from the line under test, close the air vents and/or corporation stops and raise pressure to the specified test pressure. The leakage in the section under test is defined as the quantity of water supplied to maintain pressure within 5 psig of the specified test pressure during the entire testing period. Water pipe installation is deemed to have failed the leakage test if the leakage obtained is greater than that determined by the formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

Where:

L = allowable leakage in gallons per hour

D = nominal diameter of pipe in inches

P = average test pressure in pounds per square inch

S = length of line tested in feet

If the line under test contains sections of various diameters, the allowable leakage shall be the sum of the computed leakage for each size.

3. If test results indicate that the pipe laid has leakage greater than specified, locate and repair the defective joints, fittings, pipe or valves and retest until leakage is within allowable limits. Repair visible leaks regardless of the amount of leakage.

3.3 DISINFECTION

- A. After completion of satisfactory pressure and leakage testing, disinfect the water pipelines in accordance with the recommended practice established in AWWA Standard C651. Conduct water line disinfection in the following steps:

1. Preliminary flushing.
2. Chlorine application.
3. Final flushing.
4. Bacteriologic tests.

- B. During construction, place calcium hypochlorite granules at the upstream end of the first section of pipe, at the upstream end of each branch main, and at 500 ft. intervals. Refer to AWWA C651 for quantity of granule to be used.
1. **WARNING:** This procedure must not be used on solvent welded plastic pipe or in screwed joint steel pipe because of the danger of fire or explosion from the reaction of the joint compounds with the calcium hypochlorite.
- C. Chlorine Form:
1. The chlorine form to be applied to the system shall be either chlorine gas solution, calcium hypochlorite or sodium hypochlorite. The Architect's approval of the chlorine form to be used is required.
- D. Chlorine Application:
1. Continuous Feed Method:
 - a. The continuous feed method consists of placing calcium hypochlorite granules in the main during construction, completely filling the main to remove air pockets, flushing with potable water chlorinated so that after a 24-hour holding period in the main there will be a free chlorine residual of not less than 10 mg/L.
 - b. Feed water and chlorine to the line at a constant rate such that the water will have not less than 25 mg/L free chlorine. Chlorine application shall not cease until the entire line is filled with heavily chlorinated water.
 - c. During chlorine application, take precautionary measures to prevent the concentrated treatment solution from flowing back into the existing distribution system and/or supply source.
 2. Tablet Method:
 - a. The tablet method consists of placing calcium hypochlorite granules and tablets in the water main as it is being installed and then filling the main with potable water when installation is completed.
 - 1) **NOTE:** Since the preliminary flushing step must be eliminated, this method may be used only when scrupulous cleanliness has been exercised and only with approval of the Architect. It shall not be used if trench water or foreign material has entered the main, or if the water temperature is below 41 degrees Fahrenheit.
 - b. During construction, place sufficient number of 5g calcium hypochlorite tablets in each section of pipe, in hydrants, hydrant branches, and other appurtenances to obtain a minimum of 25

mg/L available chlorine. Attach tablets to the crown of pipe sections with adhesive. Apply adhesive only to the broad side of the tablet next to the pipe surface. Refer to AWWA C651 for the proper number of 5g calcium hypochlorite tablets required.

- c. When pipeline installation is completed, fill the main with water at a maximum velocity of one foot per second. This water shall remain in the pipe for at least 24-hours. Manipulate valves so that the chlorine solution does not flow back into the line supplying the water.

3. During the 24-hour treatment, operate all valves, curb stops, and hydrants in the section treated.
4. At the completion of the 24-hour treatment, the treated water in all portions of the main shall have a residual of not less than 10 mg/L free chlorine.
5. Repeat the disinfection process until the minimum available chlorine is present at the end of the treatment sequence. The tablet method cannot be used in these subsequent disinfections. No additional compensation will be provided Contractor for repeat treatment or testing.

E. Final Flushing:

1. Flush the heavily chlorinated water from the system under treatment until the chlorine concentration in the water leaving the system is no higher than that generally prevailing in the system or is acceptable for domestic use.
2. Comply with Federal, State and local laws when discharging the flushed chlorine solution. The heavily chlorinated water shall not be directly discharged to a stream, pond, or watercourse.

F. Bacteriological Testing:

1. After final flushing is completed and before the water main is placed in service, test the line for bacteriologic quality. Perform two tests 24- hours apart.
2. Collect a minimum of one sample at the end of each line for each test, and one sample of the incoming water from the existing water system for comparison.
3. Collect samples in sterile bottles treated with sodium thiosulphate.
4. Sampling tap shall consist of corporation stop installed in the main with copper tube gooseneck assembly. No hose or fire hydrant shall be used to collect samples.
5. Provide bacteriological test reports to Owner and the Architect. Failure to

meet State health standard requirements will be cause for Contractor to rechlorinate and retest the system, at no additional cost to Owner.

6. The removal of all flushing and testing water shall be done by the Contractor at his expense.

END OF SECTION 332300

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SECTION 332400 – FIRE HYDRANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Fire Hydrants.
- B. Related Sections include the following:
 - 1. Division 3 Section: "Concrete Work for Utilities."
 - 2. Division 31 Section: "Excavation, Backfill and Compaction of Utilities."
 - 3. Division 33 Section: "Water Mains."
 - 4. Division 33 Section: "Water Main Valves."
 - 5. Division 33 Section: "Testing and Disinfecting Water Mains."

1.3 REFERENCE STANDARDS

- A. American Water Works Association (AWWA):
 - 1. AWWA C502 Dry-Barrel Fire Hydrants.
- B. Pennsylvania Department of Transportation:
 - 1. Publication 408 Specifications.
- C. Local water authority standards and specifications.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data, installation instructions, and general maintenance recommendations.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store products in areas protected from weather, moisture, or possible damage.
- B. Do not store products directly on ground.
- C. Handle products to prevent damage to interior or exterior surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. ITT Kennedy Valve; Model: Guardian K81D.

2.2 FIRE HYDRANTS

- A. Dry-barrel break-away type conforming to AWWA C502 and the following:
 - 1. Bury Depth: 5'-0" unless profile elevations on the Drawings infer an adjustment to comply with paragraph 3.2.A.2.
 - 2. Inlet Connection: 6 inch Mechanical Joint.
 - 3. Operating Nut: Standard bronze pentagon-shaped operating nut with dirt shield; open counterclockwise.
 - 4. Corrosion resistant bolts and nuts.
 - 5. One 5 inch pumper nozzle, two 2-1/2 inch hose nozzles.
 - a. Attach nozzle caps by separate chains.
 - b. National Standard thread as approved by local Fire Marshal and all governing bodies having jurisdiction on the project.
 - c. The hydrant pumper nozzle shall be of one-piece design, compatible with Storz quick-connect pumper connection. The nozzle shall be an integral part of the fire hydrant and must be furnished by the manufacturer or authorized distributor designated by the manufacturer. Storz adapters will not be accepted.
 - 6. Paint Material: Manufacturer's standard paint finish in colors consistent with municipal color schemes.
 - 7. See Drawings for additional detail information.

PART 3 – EXECUTION

3.1 GENERAL

- A. Determine the exact location, size, and construction details of hydrants from the Drawings. Obtain all necessary clarification and directions from the Architect prior to the execution of work.
- B. Perform trench excavation, backfilling and compaction in accordance with Division 31 Section “Excavation, Backfill, and Compaction of Utilities.”

3.2 FIRE HYDRANTS

- A. Install fire hydrants with separate gate valve in supply line in accordance with AWWA M17. Provide thrust blocks (min. 4 sq. ft. bearing area), and a minimum of 8 ft³ of 2B coarse aggregate for hydrant drainage around the base of the hydrant.
 - 1. Set hydrants plumb with pumper nozzle facing the curb or street.
 - 2. Set hydrants with nozzles at least 18 inches above finish grade and the ground line bead at or above finished grade such that the safety flange is not less than 2 inches nor more than 6 inches above finished grade or top of curb.
 - 3. Do not block drain hole.
 - 4. Paint hydrants which are not consistent with Municipality's color scheme or have experienced damage to the coating during shipping or installation. Coating shall consist of two (2) coats of urethane finish specified.
- B. After hydrostatic testing, flush hydrants and check for proper drainage.

END OF SECTION 332400

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SECTION 333100 – SANITARY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work of this Section includes, but is not limited to, the following:
 - 1. Gravity sanitary.
 - 2. Obtain and pay for all permits and inspections for the work under this Section.
 - 3. Include all sanitary piping shown on the civil drawings. Coordinate with the Plumbing Contractor.
- B. Related Sections include the following:
 - 1. Division 3 Section: Concrete Work for Utilities.
 - 2. Division 31 Section: Excavation, Backfill and Compaction of Utilities.
 - 3. Division 33 Section: Sanitary Sewer System Testing.

1.3 REFERENCE PUBLICATIONS

- A. ASTM D1785 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- B. ASTM D2466 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40).
- C. ASTM D2855 Standard Practice for Making Solvent - Cemented Joints with PVC Pipe and Fittings.
- D. Bristol Township Sewer Department standards and specifications.

1.4 SUBMITTALS

- A. Submit manufacturer's descriptive literature for the following items:
 - 1. Pipe, pipe fittings, joints sealing procedure.
 - 2. Submit manufacturer's certificate certifying that the following items were manufactured and tested in accordance with the applicable standards:
 - a. Pipe and pipe fittings.
- B. Certification: Furnish certification from the pipe manufacturer that the pipe will meet or exceed the requirements of the sewer authority's specifications.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Handling:
 - 1. Do not place materials on private property without written permission of the property owner.
 - 2. During loading, transporting and unloading, exercise care to prevent damage to materials.
 - 3. Do not drop pipe or fittings. Avoid shock or damage at all times.
 - 4. Take measures to prevent damage to the exterior or interior surface of the pipe.
- B. Storage:
 - 1. Pipe may be strung along alignment where approved by the Architect.
 - 2. Do not stack pipe higher than recommended by the pipe manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, manufacturers specified.

2.2 POLYVINYLCHLORIDE (PVC) PIPE

- A. The pipe, fittings and associated items shall be provided by a firm regularly engaged in the manufacture of such products of the types, materials and sizes

required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Pipe and Fittings:

1. Gravity Line:

- a. ASTM D3034 type SDR35 for gravity line (SDR26 where indicated on the drawings).

2. Joints:

- a. Solvent cement in accordance with ASTM D2855 or flexible elastomeric seals conforming to ASTM D3212 with seal material conforming to ASTM F477.

C. Polyvinylchloride (PVC) pipe shall be provided by one of the following:

- 1. J-M Manufacturing Company, Inc.
- 2. CertainTeed Corporation

2.3 CLEANOUTS

A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

1. Available Manufacturers:

- a. IPS Corporation.
- b. NDS Inc.
- c. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Unless otherwise indicated on the Drawings, provide for a minimum cover of four (4) feet above the top of piping laid in the trench based on the finished grade elevation.
- B. Provide pipe bedding as specified in Section 310500 and as shown on the Drawings for each type of pipe used. Place aggregate in a manner to avoid

segregation, and compact to the maximum practical density so that the pipe can be adequately supported.

- C. Extend piping as indicated.

3.2 LAYING PIPE IN TRENCHES

- A. Give ample notice to the Architect in advance of pipe laying operations.
- B. Lower pipe into trench using handling equipment designed for the purpose to assure safety of personnel and to avoid damage to pipe. Do not drop pipe.
- C. Lay pipe proceeding from the sewage pumping station with a constant rise to the terminal manhole.
- D. Lay pipe to a uniform line with the barrel of the pipe resting solidly in bedding material throughout its length. Excavate recesses in bedding material to accommodate joints, fittings and appurtenances. Do not subject pipe to a blow or shock to achieve solid bearing or grade.
- E. Lay each section of pipe in such a manner as to form a close concentric joint with the adjoining section and to avoid offsets in the flow line.
- F. Clean and inspect each section of pipe before joining. Assemble to provide tight, flexible joints that permit movement caused by expansion, contraction, and ground movement.
- G. Coordinate installation of sanitary piping with sanitary piping shown on the Plumbing Construction drawings.
- H. Assemble Joints as Follows:
 - 1. Push-on Joints:
 - a. Assemble joints in accordance with ASTM D2855 and manufacturer's recommendations.
 - b. Chamfer and deburr pipe. Clean socket and plain end. Measure and mark the socket depth on the outside of the pipe.
 - c. Apply primer to insider socket surface using a scrubbing motion to ensure penetration. Repeated applications may be necessary. Soften surface of male end of pipe to depth of fitting socket by applying a liberal brush coat of primer. Do not pour primer on. Assure entire surface is well softened.
 - d. Repeat application of primer to inside socket surface, then apply cement to pipe while surfaces are still wet with primer. Apply

cement uniformly taking care to keep excess cement out of socket.

- e. Immediately after applying the last coat of cement to the pipe, and while both the inside socket surface and outside pipe into the socket. Turn the pipe 1/4-turn during assembly to distribute cement evenly. Assembly should be completed with 20 seconds after the last application of cement. Insert pipe with a steady, even motion. Do not use hammer blows.
- f. Hold joint in place until cement has set. Wipe excess cement from the pipe.

2. Coupled Joints: In accordance with manufacturer's recommendations.

- I. Disassemble and remake improperly assembled joints.
- J. Check each pipe installed as to alignment in place. Correct deviation immediately. A deviation from the alignment as shown on the Drawings, or unnecessary deflection of pipe joints, will be cause for rejection.
- K. Place sufficient compacted embedment material on each section of pipe, as it is laid, to hold firmly in place.
- L. Install fittings as pipe laying progresses. Do not support weight of fittings from pipe.
- M. Clean interior of the pipe as work progresses. Where cleaning after laying is difficult because of small pipe size, use a suitable swab or drag in the pipe and pull forward past each joint immediately after the jointing has been completed.
- N. Keep trenches and excavations free of water during construction.
- O. When the work is not in progress, and at the end of each work day, securely plug open ends of pipe and fittings to prevent trench water, earth, or other substances from entering the pipes or fittings.

3.3 CUTTING PIPE

- A. Cut pipe without damaging pipe.
- B. Grind cut ends and rough edges smooth. Bevel end for push-on joints.
- C. Provide openings in manholes as required to install piping. After installation of pipe the penetration shall be sealed watertight.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

3.5 DEFLECTION

- A. When it is necessary to deflect a sanitary force main from a straight alignment horizontally or vertically, the sewage force main shall be laid in a smooth arc and the deflection of joints shall not exceed the manufacturer's recommendations.
- B. Where required, fittings shall be used to obtain required deflections.

3.6 CONCRETE AND ENCASEMENT

- A. Provide concrete encasement for pipeline where indicated on the Drawings.

3.7 THRUST RESTRAINT

- A. Provide thrust blocking in accordance with the Drawings at all fittings with a change in direction, associated with the gravity line.

3.8 TESTING

- A. Gravity line shall be tested for leakage in accordance with Section 333300.

END OF SECTION 333100

SECTION 333200 – SANITARY MANHOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Precast Concrete Manholes
 - 2. Concrete Manhole Bases
 - 3. Manhole Steps
 - 4. Manhole Covers and Frames
- B. Related Sections include the following:
 - 1. Division 31 Section “Excavation, Backfill and Compaction of Utilities”.
 - 2. Division 33 Section “Sanitary Sewerage Piping”.
 - 3. Division 33 Section “Sanitary Sewer System Testing”.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive product data for the following items:
 - 1. Pipe to manhole flexible connections.
 - 2. Gasket material used to seal manhole sections.
- B. Shop Drawings: For the following:
 - 1. Manholes: Include plans, elevations, sections, and frames and covers.

1.4 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. Standard Specifications for Highway Bridges.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 48 Specification for Gray Iron Castings.
 - 2. ASTM C 270 Specification for Mortar for Unit Masonry.
 - 3. ASTM C 478 Specification for Precast Reinforced Concrete Manhole Sections.
 - 4. ASTM C 923 Specification for Resilient Connections between Reinforced Concrete Manhole Structures and Pipes.
- C. Federal Specification:
 - 1. SS-S-00210 Joint Sealant Compound.
- D. Bristol Township Sewer Department standards and specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Sanitary manhole structures:
 - a. A.C. Miller Concrete Products, Inc.
 - b. Monarch Precast Concrete Corporation.
 - c. Modern Concrete Septic Tank Company.
 - 2. Manhole frames and covers:
 - a. Neenah Foundry Company.
 - b. Woodward Foundries, Inc.
 - c. Campbell Foundry Company.

2.2 BASIC MATERIALS

- A. Coarse Aggregate Subbase:
 - 1. ASTM C-33, No. 57 stone.
- B. Masonry Mortar: ASTM C270, Type S.
- C. Concrete: Section 033000.
- D. Joint Sealant Compound: FS SS-S-00210, preformed, flexible, self-adhering, cold-applied; as manufactured by A-Lok Products Inc. ("Butyl-Lok"), K.T. Snyder Company, Inc. ("Ram-Nek") or approved equal.
- E. Resilient Pipe-to-Manhole Connection: ASTM C923

2.3 FABRICATED PRODUCTS

- A. Precast Concrete Manhole Sections: ASTM C478
 - 1. 5.5% ±1% air-entrained cement concrete.
 - 2. Eccentric cone section (Type 'A'), or top slab (Type 'B'), minimum 24" access opening unless otherwise indicated.
 - 3. Precast riser sections of length to suit.
 - 4. Precast bases of a design similar to the precast riser sections.
 - 5. Provide an integral flexible resilient connection to serve as a seal between the precast base section and each pipe.
 - 6. A coal tar epoxy protective coating shall be applied to the entire outer surface. The coating shall consist of two (2) coats, each eight (8) mils thick, of Koppers Bitumastic No 300-M or approved equal, applied as recommended by the manufacturer.
- B. Manhole Steps:
 - 1. Copolymer polypropylene plastic reinforced with grade 60 steel as indicated on the drawings with serrated tread.
- C. Manhole Frames and Covers:
 - 1. Domestic cast iron castings: ASTM A48, Class 30 or better; free of bubbles, sand and air holes, and other imperfections.

2. Heavy duty traffic, AASHTO Highway Loading Class H-20. (16,000# wheel loading)
3. Contact surfaces machined and matched.
4. All manhole covers shall be inscripted with wording as indicated on drawing details with raised letters. Letters shall have a height and width of not less than two (2) inches.
5. All manhole covers shall have two (2) concealed pick holes.
6. All manhole covers shall be the watertight, bolt-down type with O-ring gasket, four (4) bolt holes in frame and cover and 1/2 inch diameter bronze or stainless steel hex head bolts.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Location and depth of manholes as shown on the Drawings.

3.2 CONSTRUCTION

- A. Construct watertight manholes of precast concrete sections and of the type shown on the Drawings. Drop manholes shall be provided where the invert drop is two (2) feet or more.
- B. Install precast base on a minimum of six (6) inches of coarse aggregate subbase.
 1. An integral resilient connection shall be provided at each pipe location which will serve as a watertight seal.
- C. Install sewer connections to manhole base.
 1. Where soft or unstable soil conditions exist, the maximum length of pipe from the manhole base shall be:
 - a. Five (5) feet for new precast base.
 - b. Two (2) feet for new cast-in-place base and connections to existing base.
 2. Pipe shall not project more than 2-inches into the manhole.

3. The bottom portion of the annular space around the sewer pipe within the inside of the manhole shall be filled with non-shrink grout to match the channel. No grout shall be used on the upper portion of the annual space or in the exterior annular space.
- D. Form flow channels in manhole bases as shown on the Drawings. Slope channels uniformly from influent invert to effluent invert. Slope bench towards channel at 1 inch per foot. Construct bends of the largest possible radius. Form channel sides and invert smooth and uniform; free of cracks, holes or protrusions.
- E. Seal joints between precast concrete manhole sections with two (2) rings of preformed joint sealant compound.
 1. Place joint sealant compound on lower section to be squeezed by the weight of the upper section.
- F. Install manhole sections with steps in proper vertical alignment.
- G. Use precast concrete grade rings to achieve elevation shown for frame and cover. Do not adjust elevation more than one (1) foot with precast rings. Provide the exterior of the grade rings with a ½-inch thick coat of mortar.
- H. Install manhole frames and covers.
 1. Set top of frames at finished grade elevation or other elevation shown on the Drawings.
 2. Anchor manhole frame to the precast structure at four (4) locations as shown on the Drawings.
 3. Seal joint between manhole frame and manhole with joint sealant compound.
 4. Provide watertight covers.

3.3 TESTING

- A. Manholes shall be tested for leakage in accordance with Section 333100.

END OF SECTION 333200

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SECTION 333300 – GRAVITY SANITARY SEWER SYSTEM TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Testing Sanitary Sewer Pipelines:
 - a. Low-pressure air test.
 - b. Exfiltration test.
 - c. Force main hydrostatic test.
 - 2. Deflection Testing of Plastic Pipe.
- B. Related Sections include the following:
 - 1. Division 33 Section “Sanitary Sewerage Piping.”

1.3 SUBMITTALS

- A. Testing procedures.
- B. List of test equipment.
- C. Testing sequence schedule.
- D. Testing results.
- E. Provisions for disposal of flushing and test water.
- F. Certificate of test gauge calibration.
- G. Deflection mandrel drawings and calculations.

1.4 QUALITY ASSURANCE

- A. Test Acceptance: No test will be accepted until the results are below the specified maximum limits.
 - 1. Contractor shall, at his own expense, determine and correct the causes of test failure and retest until successful test results are achieved.
- B. Testing shall be performed in compliance with the local sewer authority requirements.

1.5 JOB CONDITIONS

- A. Do not allow personnel in manholes during low-pressure air testing.
- B. Provide relief valves set at 10 psig to avoid accidentally over-pressurizing gravity sanitary sewer line during low pressure air testing.

PART 2 - PRODUCTS

2.1 AIR TEST EQUIPMENT

- A. Air compressor.
- B. Air supply line.
- C. Shut-off valve.
- D. Pressure regulator.
- E. Pressure relief valve.
- F. Stop watch.
- G. Plugs.
- H. Pressure gauge, calibrated to 0.1 lbs/sq. in.
- I. All other equipment and accessories as required.

2.2 HYDROSTATIC TEST EQUIPMENT

- A. Water pump.
- B. Pressure hose.

- C. Water meter.
- D. Test connections.
- E. Pressure gauge, calibrated to 0.1 lbs/sq. in.
- F. Pressure relief valve.
- G. All other equipment and accessories as required.

2.3 EXFILTRATION TEST EQUIPMENT

- A. Means of water volume measurement.
- B. All other equipment and accessories as required.

2.4 DEFLECTION TEST EQUIPMENT

- A. Go, No-Go mandrels.
- B. Pull/retrieval ropes.
- C. All other equipment and accessories as required.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Plug outlets, wye-branches and laterals. Brace plugs to offset thrust.
- B. Provide pressure pipeline with concrete reaction support blocking.
- C. Flush pipeline to remove debris. Collect and dispose of flushing water and debris but do not discharge directly to a stream or water course.
- D. Clean pipelines by propelling a snug fitting rubber ball through the pipeline with water from the upstream manhole to the downstream manhole. Investigate and correct any stoppage of the cleaning ball. Collect and dispose of cleaning water and debris but do not discharge directly to a stream or water course.
- E. Lamping: After flushing and cleaning, lamp gravity pipeline in the presence of the Owner's Representative.
 - 1. Assist the Owner's Representative in the lamping operation by shining a light at one end of each pipeline section between manholes. The

Owner's Representative will observe the light at the other end. Pipeline that has not been installed with uniform line and grade will be rejected. Remove and re-lay rejected pipeline sections. Re-clean and lamp until pipeline section achieves a uniform line and grade to the satisfaction of the Owner's Representative.

3.2 TESTING SANITARY SEWER PIPELINES

A. Low Pressure Air Test:

1. Test each newly installed section of gravity sewer line between manholes.
2. Slowly introduce air pressure to approximately 4.0 psig.
 - a. If ground water is present, determine its elevation above the springline of the pipe by means of a piezometric tube. For every foot of ground water above the springline of the pipe, increase the starting air test pressure reading by 0.43 psig. Do not increase pressure above 10 psig.
3. Allow pressure to stabilize for at least five minutes. Adjust pressure to 3.5 psig or the increased test pressure as determined above if ground water is present. Start the test.
4. Test: Determine the test duration for a sewer section with a single pipe size from the table below:

Low Pressure Air Test - Test Times (Minutes)

<u>Nominal Pipe Size</u>	<u>T (Time) Min/100 Ft</u>	<u>Nominal Pipe Size</u>	<u>T (Time) Min/100 Ft</u>
1	.3	21	3.0
6	.7	24	3.6
8	1.2	27	4.2
10	1.5	30	4.8
12	1.8	33	5.4
15	2.1	36	6.0
18	2.4		

- a. Record the drop in pressure during the test period. If the air pressure has dropped more than 1.0 psig during the test period, the line is presumed to have failed. If the 1.0 psig air pressure drop has not occurred during the test period, the test shall be discontinued and the line will be accepted.

- b. If the line fails, determine the source of the air leakage, make corrections and retest. Contractor has the option to test the section in incremental stages until the leaks are isolated. After the leaks are repaired, retest the entire section between manholes.

B. Exfiltration Test:

1. Test each newly installed section of gravity sewer line between manholes.
2. All pipe openings shall be sealed with plugs designed to provide a water tight seal.
3. If ground water is present, determine its elevation by means of a piezometric tube.
4. The sewer section being tested shall be filled with water to a level sufficient to provide a minimum positive head two (2) feet higher than the crown at the upgradient end of the sewer line or two (2) feet higher than the ground water level whichever is greater.
5. The sewer line being tested shall be considered "acceptable" when the total rate of exfiltration does not exceed 100 gallons per inch of internal pipe diameter per mile of pipe per day.
6. If the sewer line being tested indicates leakage greater than that allowed, the source of the leakage shall be located and corrected and the sewer line retested until the leakage is within the allowable limit.

3.3 DEFLECTION TESTING OF PLASTIC SEWER PIPE

A. Vertical Ring Deflection Test:

1. Perform vertical ring deflection testing on all portions of PVC sewer piping, in the presence of the Architect, after backfilling has been in place for at least 30 days but not longer than 12 months.
2. The maximum allowable deflection for installed plastic sewer pipe shall be limited to 5% of the original vertical internal diameter.
3. Perform deflection testing with a deflectometer, calibrated television, or a properly sized "Go, No-Go" mandrel. The mandrel(s) shall be constructed at Contractor's expense and subject to the approval of the Architect.
4. Pipe exceeding the allowable deflection shall be located, excavated, replaced, and retested at the sole expense of Contractor.

3.4 INTERNAL INSPECTION

- A. Final acceptance of the sewer system may be contingent upon television inspection of some or all of the sewer mains by and at the discretion of Owner. Any repairs which must be made as a result of this inspection shall be Contractor's responsibility.

END OF SECTION 333300

SECTION 334100 – STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY OF WORK

- A. Extent of storm sewage systems work is indicated on the drawings and by requirements of this section.
- B. Include all manholes, inlets, catch basins, outlet structures, precast endwalls, flared end sections, area drains, etc. in conjunction with storm sewer work.
- C. Related Sections include the following:
 - 1. Division 3 Section "Concrete Work for Utilities" for concrete materials.
 - 2. Division 31 Section "Excavation, Backfill and Compaction of Utilities" for excavation and backfilling for all storm drainage system work.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for all storm sewage system materials and products.
- B. Shop Drawings: For the following:
 - 1. Manholes: Include plans, elevations, sections, details, and frames and covers.
 - 2. Yard Inlets, Precast Headwall/Endwalls, Outlet Structures, Flared End Sections, and Stormwater Inlets: Include plans, elevations, sections, details, and frames, covers, and grates.
- C. Maintenance Data: Submit maintenance data and parts lists for storm sewage system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: All work shall be performed in accordance with methods and details indicated on the plans, local township standards, PennDOT Standard Form 408 latest edition as amended and all regulatory bodies having jurisdiction on this work.
- B. Environmental Compliance: Comply with applicable portions of respective County Conservation District regulations pertaining to storm sewage systems.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM C 76: Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - 2. ASTM F 405: Standard Specification for Corrugated Polyethylene Pipe and Fittings.
 - 3. ASTM F 477: Standard Specifications for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 4. ASTM D 2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- D. AASHTO Specifications:
 - 1. AASHTO M170: Standard Specifications for Reinforced Concrete Pipe.
 - 2. AASHTO M252: Standard Specification for Polyethylene Corrugated Drainage Pipe.
 - 3. AASHTO M294: Standard Specification for Corrugated Polyethylene Pipe, 12 inch to 48 inch diameter.

1.5 PROJECT CONDITIONS

- A. Site Information: Perform complete site review and investigation, research public utility records, and verify existing utility locations. Contact utility-locating service for area where project is located.
- B. Locate existing structures and piping to be removed, closed, or abandoned where required.
- C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1. Notify the utility owner not less than 72 hours in advance of any proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving the jurisdictional authority's written permission.
3. Secure any permits as required by the jurisdictional authority.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 Articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 CORRUGATED HIGH DENSITY POLYETHYLENE STORM SEWER PIPE

- A. Materials: Pipes, couplings, inlets, cleanouts and fittings shall be made of polyethylene compounds, and shall meet all applicable requirements of AASHTO M294 current edition Type S or Type D for pipe and sizes 12 inches in diameter and larger. Polyethylene pipes, couplings, and fittings less than 12 inches in diameter shall meet the requirements of AASHTO M252 current edition. Bends, tees, wyes, etc. will be standard fabricated fittings. The pipes and fittings shall be free of foreign inclusions and visible defects and pipe shall be cut squarely and cleanly so as not to adversely affect joining or connecting. Visible defects such as cracks, creases, unpigmented or nonuniformly pigmented pipe are not permissible in the pipe as furnished.
 1. The pipe as noted below shall have minimum pipe stiffness at five percent deflection when tested in accordance with the requirements of ASTM D-2412:

<u>Diameter (inches)</u>	<u>Pipe Stiffness (psi)</u>
12	50
15	42
18	40
24	34
30	28
36	22
42	19
48	17

- B. Joints for all pipe and fittings shall use gasketed watertight bell/spigot or bell/bell couplers. The gaskets shall meet the requirements of ASTM F477 and the joint system shall be certified to meet ASTM D3212. In addition, the joint system shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joint.
- C. The Contractor shall provide a manufacturer's certificate signed by a manufacturer's representative stating the product was manufactured, tested, and supplied in accordance with all the applicable requirements of AASHTO M294 (or AASHTO M252 as applicable), ASTM F477 and ASTM D3212.
- D. Geotextile Fabric: Non-woven, needle punched, polypropylene to be installed with the perforated storm sewer pipe where indicated on the drawings. The installation shall be a Class 1 Geotech trench envelope in accordance with PennDOT Publication 408 Sections 212.3(b) and 735, current edition.

2.3 REINFORCED CONCRETE PIPE

- A. Material: Pipe shall be Class III or Class IV as indicated, reinforced concrete pipe, AASHTO designation M170, in accordance with ASTM C-76. All reinforced concrete pipe shall be stamped with:
 - 1. The name or trademark of the manufacturer.
 - 2. The pipe class, type of wall, and size of pipe.
 - 3. The date of manufacture.
- B. Joints: Tongue and groove gasketed joint type complying with ASTM C443.
- C. Mortar: Mortar for lift holes shall be composed of materials designated under the concrete specifications. Mortar shall be used within forty-five (45) minutes subsequent to mixing. Mortar that has stiffened shall not be remixed and used.

2.4 PRECAST CONCRETE STRUCTURES

- A. Portland cement shall conform to ASTM C 150 with aggregates conforming to ASTM C 33. Minimum compressive strength shall be 3750 PSI. The water-cement ratio shall be 0.45. The minimum cement content shall be 564 lb/cy. Cement shall be Type I, IA, II, IIA, III, or IIIA. The air content shall be 6±1%. Air-entraining admixtures shall meet the requirements of ASTM C260.
- B. Reinforcing steel shall conform to ASTM A 615 grade 60 for bars or ASTM A 185 for welded wire fabric.

2.5 INLET AND BASIN OUTLET STRUCTURES

- A. General: The Contractor shall provide precast inlets and outlet structures at the locations and to the dimensions and elevations shown on the drawings. The inlets shall be the type inlets indicated on the drawings and constructed as specified by the local township standard construction details, PennDOT Standard Construction Details, and PennDOT RC-standards, latest edition, and as shown on the plans. Included shall be all necessary excavation, precast concrete sections, steps, gaskets, brick masonry, frame and grate, concrete flow channels, backfilling and all necessary appurtenances for completion. Include all weepholes indicated on inlets to provide sub-surface drainage from adjoining areas.
1. In lieu of precast inlets the Contractor may field construct the inlets to the same specifications.
- B. Materials: Materials for the inlets shall conform to the following PennDOT Specification Publication 408 Sections, latest edition, as amended.
1. Class A Concrete - Section 704.1. Concrete shall be air entrained.
 2. Brick - Section 713.1.
 3. Reinforcement - Sections 709.1 and 709.3.
 4. Structural Steel - Section 1052.01 (Form 409).
 5. Mortar - Section 705.7.
 6. Brick Masonry - Section 663.2.
 7. Precast Cement Concrete Units - Section 713.2.
 8. Trash Racks: #4 epoxy coated rebar.
- C. Outlet Structure Restricting Plates: Install 3/8" thick stainless steel plate with required orifices as indicated on the drawings. Fasten to the outlet box with stainless steel angles and 3/8" diameter stainless steel bolts.
- D. Frame and Grates: Frames shall be grey, malleable or ductile-iron castings or structural steel. Structural steel grates shall be used on basin outlet structures and structural steel bicycle grates for all inlets. Coat frames and grates with bituminous paint.
- E. Steps: Construct steps in inlets that exceed five (5) feet in height. The steps shall be copolymer polypropylene plastic conforming to ASTM D4141-95B PP0344B33534Z02 with a 1/2" deformed reinforcing rod, Grade 60, conforming to ASTM A615.

2.6 MANHOLES

- A. Precast Manholes: Conform to local township standard construction details, PennDOT Specifications Publication 408, Sections 605, 606, and 714 and ASTM C-478 for "Specifications for Precast Reinforced Concrete Manhole Sections". Concrete shall be air-entrained. Form flow channels in bases.
 - 1. Masonry Mortar: Conform to ASTM C-270.
- B. Frames and Covers: Conform to local township standard cast iron storm sewer manhole frame and cover, and PennDOT Publication 408 Sections 605.2(b), latest edition. Frames and covers shall be heavy duty AASHTO Highway Loading Class HS-25. Cover shall have word "STORM SEWER" inscripted with 2" high, raised letters and have 2 pick holes. Coat frames and covers with bituminous paint.
- C. Manhole Steps: Construct steps in manholes that exceed five feet in height. The steps shall be copolymer polypropylene plastic with 1/2" grade 60 steel reinforcement bar.

2.7 TRENCH DRAINS

- A. Trench Drains: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading.
 - 1. Product: R-4990-CX Type "A" trench drain with Type "X" frame; Neehan Foundry Co. or approved equal.
- B. Drain Piping: Install 8" diameter high density polyethylene pipe from the trench drains to the storm drainage system as indicated on the drawings. Include the appropriate fittings and couplings necessary to connect the pipe to the trench drain outlets.

2.8 HEADWALL/ENDWALLS

- A. Headwall/Endwalls: Install precast concrete Type D-W headwall/endwalls in accordance with local township details and PennDOT Specifications Publication 408, Sections 605 and 714 standard details as indicated on the drawings.
 - 1. Permanent Trash Racks: Install #4 rebar trash racks, with rust proof coating, on all headwall/endwalls in accordance with PennDOT standard details.

2.9 CONCRETE WORK

- A. Class AA Concrete:
 - 1. 28 Day Compressive Strength: 3750 psi.

2. Slump: 1 to 3 inches.
 3. Use for all precast concrete.
- B. Class A Concrete:
1. 28 Day Compressive Strength: 3300 psi.
 2. Slump: 1 to 3 inches.
 3. Use for all site cast concrete.
- C. Cement factor and maximum water cement ratio shall conform to Table A, Section 704.1 (b), PennDOT 408 Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: No pipe shall be laid on frozen or thawing material or during wet weather conditions. Each pipe shall be subject to observation by the Architect, and those not meeting the specified requirements shall be removed from the work site. Delivery slips from the pipe suppliers shall be kept on the work site and furnished, upon request, to the Architect. The Architect shall have the right to make changes in the line and grade of all storm sewers as may be necessary or advantageous.
- B. Lay pipe proceeding upgrade with the bell or groove pointing upstream.
- C. Line and Grade Checks: The Contractor shall check each section of pipe from the string line and grade board or other approved methods. A variation of one quarter (1/4) inch or more from the true invert grade and a variation of one (1) inch or more from the true line will be sufficient reason for the Architect to order the work to be rejected.
- D. Installation of the underground stormwater detention piping shall be in accordance with ASTM D2321.
1. See civil drawings for additional stormwater detention basin installation notes.

3.2 PIPE LAYING

- A. Pipe shall be installed as per notes and details of the drawings and in accordance with the requirements of PennDOT Specifications, ASTM D2321, or the manufacturer's recommendations, whichever are more stringent. The Contractor

should be aware that for different sizes of pipe different requirements shall govern. All connections shall be assembled in accordance with the manufacturer's recommendations to produce secure, tight joints.

- B. All pipe shall be laid and maintained to the required lines and grades shown on the Contract Drawings.
- C. A geotextile fabric envelope shall be installed for the perforated storm sewer pipe with sufficient material to completely encapsulate the aggregate.
- D. Following the trench preparation, pipe laying shall proceed from the downgrade end. Pipe ends shall be carefully cleaned before pipes are lowered into the trench.
- E. Each section of pipe shall be placed so that the full length of its barrel rests on six inches of bedding material. Each section of pipe shall be firmly held in position so that its invert forms a continuous grade with the invert of the previously laid pipe.
- F. The end of the pipe shall be protected with a stopper to prevent the entrance of water, earth, stones, or other debris. Any debris entering the pipe shall be removed immediately to the satisfaction of the Architect.
- G. Walking or working on the completed pipe line, except as may be necessary in tamping or backfilling, shall not be permitted until the trench has been backfilled to a height of at least eighteen inches over the top of the pipes.
- H. Storm sewer pipe that has its grade or joints disturbed after laying shall be taken up and relaid. Any section of pipe already laid and found to be defective shall be taken up and replaced with new pipe by the Contractor.
- I. At manholes and inlet and outlet structures, the pipe shall be installed with a watertight penetration.
- J. Joints in corrugated polyethylene pipe shall be made with the specified watertight couplings.
- K. Concrete Pipe Joints: Joints in reinforced concrete piping shall be assembled in accordance with the manufacturer's specifications using gasketed joints.

3.3 INLETS AND OUTLET STRUCTURES, MANHOLES, AND HEADWALL/ENDWALLS

- A. All structures shall conform to the lines and grades given, and to the dimensions and design as indicated on the drawings.
- B. Inlet and outlet structures, manholes, and headwall/endwalls shall be constructed using precast units. All reinforcing shall conform to PennDOT Standard Construction Details, DWG. RC-34.

- C. Cement concrete construction shall comply with the applicable requirements of PennDOT Specifications Publication 408 Section 713, and shall be air entrained concrete.
- D. Masonry construction shall comply with the applicable requirements of PennDOT Specifications Publication 408 Section 713.
- E. Inlets shall be constructed in accordance with the requirements specified in PennDOT Specifications Publication 408, Section 605, RC 34 and plan details.
- F. The pipes in inlets shall be flush with the inside face of the structure.
- G. Spaces excavated for but not occupied by these structures, shall be backfilled with acceptable material in uniform loose layers not exceeding eight (8) inches in depth, and be compacted by means of approved mechanical tampers.

3.4 FIELD QUALITY CONTROL

- A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose or put into service before inspection and approval.
 - 2. Test completed piping systems according to authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
- B. Replace failed piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 334100

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SECTION 334110 – ROCK ENERGY DISSIPATER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Rock Energy Dissipater, also indicated as rip-rap or pipe outlet protection.
- B. Related Sections include the following:
 - 1. Division 31 Section “Site Clearing.”
 - 2. Division 31 Section “Earthwork.”
 - 3. Division 31 Section “Sedimentation and Erosion Control Systems.”
 - 4. Division 33 Section “Storm Drainage System.”

1.3 REFERENCE STANDARDS

- A. Pennsylvania Department of Transportation Specifications Publication 408.
- B. PennDOT Publication 72 Standards for Roadway Construction.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer’s descriptive product data for the following:
 - 1. Geotextile Fabric.

1.5 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

- A. Rock: Acceptable quality; sound; free from structural objects and foreign substances.
 - 1. Rock must come from material providing a Type A coarse aggregate per PennDOT Specifications Publication 408, Section 703.2.
 - 2. Rock size and gradation shall conform to the indicated size and as set forth in PennDOT Specifications Publication 408, Section 850.

2.2 PRODUCTS

- A. Geotextile Fabric: Fabric shall be 16 oz. nonwoven type conforming with Section 735, Publication 408 Specifications for Class 2, Type B for erosion control. Geotextile fabric shall be Amoco 1199 or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform clearing, grubbing, excavation and/or placing embankment in accordance with Division 31 Sections "Site Clearing" and "Earthwork" as required at location(s) shown on Drawings.
- B. Remove unsuitable material below the energy dissipater and replace with acceptable material.

3.2 INSTALLATION

- A. Energy dissipater shall be constructed of such size and configuration as shown on the Drawings.
- B. Geotextile fabric shall be placed under the proposed rock energy dissipater in accordance with Section 212.3(c), PennDOT Publication 408 Specifications and the Drawings.
- C. Rock shall be carefully placed on the geotextile fabric to produce an even distribution with minimum of voids and without tearing the geotextile fabric. Install rocks in 2 layers.
- D. Rock shall be placed in full thickness in one operation in a manner to prevent segregation and rearranged, as necessary to insure uniform distribution.

END OF SECTION 334110

SECTION 337119 - ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nonmetallic duct.
- B. Manholes.

1.2 RELATED REQUIREMENTS

- A. Section 312316 - Excavation.
- B. Section 312323 - Fill: Bedding and backfilling.
- C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.
- D. Section 033000 - Cast-in-Place Concrete.

1.3 REFERENCE STANDARDS

- A. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures; 2012a.
- B. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures; 2010e1.
- C. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures; 2011.
- D. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures; 2008.
- E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).
- F. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.
- G. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.

- H. NEMA TC 6&8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations; National Electrical Manufacturers Association; 2003.
- I. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation; National Electrical Manufacturers Association; 2004.
- J. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- L. UL 1684 - Standard For Safety For Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for nonmetallic conduit and manhole accessories.
- C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 CONDUIT AND DUCT

- A. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, with fittings and conduit bodies to NEMA TC 3.
- B. Reinforced Resin Conduit and Fittings: Complying with UL 1684.
 - 1. Joining Method: Tapered bell and spigot joints.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.2 PRECAST CONCRETE MANHOLES

- A. Description: Precast manhole designed in accordance with ASTM C858, comprising modular, interlocking sections complete with accessories.
- B. Loading: ASTM C857, Class A-16.
- C. Shape: Square.
- D. Nominal Inside Dimensions: 4 feet x 6 feet.
- E. Inside Depth: 7 feet.
- F. Wall Thickness: 6 inches.
- G. Base Section: Include 3 inch deep x 14 inch round sump with cast sleeve, and two 1 inch ground rod openings.
- H. Top Section: Include 39 inch diameter grooved opening for frame and cover.
- I. Riser Casting: 6 inch, with manhole step cast into frame.
- J. Frames and Covers: ASTM A48; Class 30B gray cast iron, 27 inch size, machine finished with flat bearing surfaces. Provide cover marked ELECTRIC to indicate utility.
- K. Duct Entry Provisions: Window knockouts.
- L. Duct Entry Size: 6 inch.

- M. Cable Pulling Irons: Use galvanized rod and hardware. Locate opposite each duct entry. Provide watertight seal.
- N. Cable Rack Inserts: Minimum load rating of 800 pounds (365 kg). Locate as required for pulling of cables.
- O. Cable Rack Mounting Channel: 1-1/2 x 3/4 inch steel channel, 48 inch length. Provide cable rack arm mounting slots on 1-1/2 inch centers.
- P. Cable Racks: Steel channel, 1-1/2 x 3/4 x 14 inches, with fastener to match mounting channel.
- Q. Cable Supports: Porcelain clamps and saddles.
- R. Manhole Steps: Polypropylene plastic manhole step with 1/2-inch steel reinforcement.
- S. Source Quality Control: Inspect manholes in accordance with ASTM C1037.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Verify locations of manholes prior to excavating for installation.
- D. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.
- E. Manhole locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.

3.2 DUCT BANK INSTALLATION

- A. Install duct to locate top of ductbank at depths as indicated on drawings.
- B. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.
- C. Cut duct square using saw or pipe cutter; de-burr cut ends.

- D. Insert duct to shoulder of fittings; fasten securely.
- E. Install no more than equivalent of three 90-degree bends between pull points.
- F. Provide suitable fittings to accommodate expansion and deflection where required.
- G. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- H. Use suitable separators and chairs installed not greater than 4 feet on centers.
- I. Band ducts together before backfilling.
- J. Securely anchor duct to prevent movement during concrete placement.
- K. Place concrete under provisions of Section 033000. Use mineral pigment to color concrete red.
- L. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.
- M. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.
- N. Provide suitable pull string in each empty duct except sleeves and nipples.
- O. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- P. Interface installation of underground warning tape with backfilling. Install tape 12 inches below finished surface.

3.3 PRE-CAST MANHOLE INSTALLATION

- A. Excavate for manhole installation under the provisions of Section 312316.
- B. Install and seal precast sections in accordance with ASTM C891.
- C. Install manholes plumb.
- D. Use precast neck and shaft sections to bring manhole cover to finished elevation.
- E. Attach cable racks to inserts after manhole installation is complete.
- F. Backfill manhole excavation under the provisions of Section 312323.

END OF SECTION 337119

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