

Project Manual

Volume 3



Prepared for:

Great Valley School District

301 Lindenwood Drive, Suite 210
Malvern, PA 19355

Project:

**Renovations to:
District Administration Office**

Prepared by:

SCHRADERGROUP

161 Leverington Avenue, Suite 105
Philadelphia, Pennsylvania 19127

Bid Submission:

21 December 2022

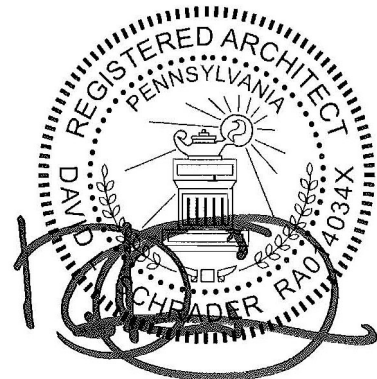


TABLE OF CONTENTS

Copyright

VOLUME 1 – DIVISION 0-1

DRAWING INDEX

As Listed On Contract Drawings Cover Sheet

DIVISION 00 – BIDDING AND CONTRACT REQUIREMENTS

Section 001113 -	Bid Advertisement
Section 002000 -	Instructions to Bidders
Section 002100 -	Supplemental Instructions to Bidders
Section 002110a -	Background Checks
Section 002110b -	Act 24 Form
Section 004116 -	Bid Form Contract 1 - General Construction
Section 004117 -	Bid Form Contract 2 - Plumbing Construction
Section 004118 -	Bid Form Contract 3 - Mechanical Construction
Section 004119 -	Bid Form Contract 4 - Electrical Construction
Section 004200 -	Bid Attachments
Section 004210 -	Waiver of Liens
Section 005200 -	Agreement Between Owner and Contractor
Section 006100 -	Performance Bond
Section 006120 -	Payment Bond
Section 007000 -	General Conditions
Section 008200 -	Prevailing Wages
Section 009000 -	Construction Forms

DIVISION 01 – GENERAL REQUIREMENTS

Section 011000 -	Summary of Work
Section 011200 -	Multiple Contract Summary
Section 012300 -	Alternates
Section 012500 -	Contract Modification Procedures
Section 012900 -	Payment Procedures
Section 013110 -	Project Meetings
Section 013200 -	Construction Progress Documentation
Section 013300 -	Submittal Procedures
Section 013500 -	Safety
Section 014100 -	Regulatory Requirements
Section 014200 -	References
Section 015100 -	Temporary Utilities and Facilities
Section 015300 -	Temporary Barriers and Enclosures
Section 016100 -	Basic Product Requirements
Section 016300 -	Products Substitution Procedures

- Section 017400 - Cleaning
- Section 017700 - Closeout Procedures
- Section 017800 - Project Record Documents
- Section 017810 - Warranties and Bonds

VOLUME 2 – DIVISION 2 – 14

DIVISION 2 – SITEWORK

- Section 024113 - Selective Demolition

DIVISION 3 – CONCRETE

- Section 035416 - Self Leveling Underlayment

DIVISION 4 – MASONRY

- Section 042000 - Unit Masonry

DIVISION 5 - METALS

- Section 055000 - Metal Fabrications

DIVISION 6 – WOOD, PLASTICS, COMPOSITES

- Section 061053 - Miscellaneous Rough Carpentry
- Section 062020 - Interior Finish Carpentry

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

- Section 072100 - Thermal Insulation
- Section 072129 - Sprayed Insulation
- Section 079200 - Joint Sealants

DIVISION 8 - OPENINGS

- Section 081113 - Hollow Metal Doors and Frames
- Section 081416 - Flush Wood Doors
- Section 083113 - Access Doors and Frames
- Section 084113 - Aluminum-Framed Entrances and Storefronts
- Section 087100 - Door Hardware
- Section 087113 - Automatic Door Operators
- Section 088000 - Glazing
- Section 088713 - Window Film

DIVISION 9 - FINISHES

- Section 092216 - Non-Structural Metal Framing

Section 092813	-	Cementitious Backing Board
Section 092900	-	Gypsum Board
Section 092940	-	Gypsum Trim and Accessories
Section 093013	-	Ceramic Tiling
Section 095113	-	Acoustical Panel Ceilings
Section 096513	-	Resilient Base and Accessories
Section 096519	-	Resilient Flooring
Section 096813	-	Tile Carpeting
Section 097200	-	Digitally Printed Vinyl Wallcoverings
Section 099123	-	Interior Painting

DIVISION 10 - SPECIALTIES

Section 101100	-	Visual Display Units
Section 101419	-	Dimensional Letter Signage
Section 101423	-	Signage
Section 102113	-	Toilet Compartments
Section 102215	-	Sliding/Fixed Glass Panel Partitions
Section 102226	-	Operable Panel Partitions
Section 102800	-	Toilet and Bath Accessories
Section 104413	-	Fire Protection Cabinets
Section 104416	-	Fire Extinguishers

DIVISION 11 – EQUIPMENT

N/A

DIVISION 12 - FURNISHINGS

Section 122413	-	Roller Window Shades
Section 123216	-	Manufactured Plastic-Laminate-Faced Casework
Section 123600	-	Miscellaneous Countertops
Section 126613	-	Solid Surface Countertops

DIVISION 13 – SPECIAL CONSTRUCTION

N/A

DIVISION 14 – CONVEYING EQUIPMENT

N/A

VOLUME 2

DIVISION 21 - FIRE SUPPRESSION

Section 210100	-	General Provisions
Section 210101	-	Removals

Section 210500	Common Work Results for Fire Suppression
Section 210553	Identification for Fire Suppression Piping and Equipment
Section 211300	Fire-Suppression Sprinkler Systems

DIVISION 22 - PLUMBING

Section 220100	General Provisions
Section 220101	Removals
Section 220502	Excavation, Backfill & Compaction for Utility Trenches
Section 220519	Meters and Gages for Plumbing Piping
Section 220553	Identification for Plumbing Piping and Equipment
Section 220719	Plumbing Piping Insulation
Section 221005	Plumbing Piping
Section 221006	Plumbing Piping Specialties
Section 223000	Plumbing Equipment
Section 223300	Electric Water Heaters
Section 224000	Plumbing Fixtures

DIVISION 23- HEATING, VENTILATION AND AIR CONDITIONING

Section 230501	HVAC General Requirements
Section 230513	Common Motor Requirements for HVAC Equipment
Section 230514	Adjustable Frequency Drives
Section 230515	Removals
Section 230519	Meters and Gages for HVAC Piping And Equipment
Section 230549	Vibration Isolation
Section 230554	Mechanical Identification
Section 230593	Testing, Adjusting, And Balancing for HVAC
Section 230714	HVAC Duct Insulation
Section 230923	Direct Digital Control (DDC) System
Section 230993	HVAC Control Sequence
Section 232300	Refrigerant Piping
Section 233100	HVAC Ducts and Casings
Section 233300	Air Duct Accessories
Section 233416	Centrifugal HVAC Fans
Section 233600	Air Terminal Units
Section 233700	Air Outlets and Inlets
Section 234000	HVAC Air Cleaning Devices
Section 237302	Rooftop Air Handling Units
Section 238101	Terminal Heat Transfer Units
Section 238127	Small Split System Heating and Cooling

DIVISION 26 – ELECTRICAL

Section 260100	General Requirements
Section 260505	Selective Demolition for Electrical
Section 260519	Low-Voltage Electrical Power Conductors and Cables
Section 260526	Grounding and Bonding for Electrical Systems

Section 260529	Hangers and Supports for Electrical Systems
Section 260534	Conduit
Section 260536	Cable Trays for Electrical Systems
Section 260537	Boxes
Section 260553	Identification for Electrical Systems
Section 260573	Power Systems Studies
Section 260923	Lighting Control Devices
Section 260924	Lighting Control System
Section 262200	Low-Voltage Transformers
Section 262416	Panelboards
Section 262717	Equipment Wiring
Section 262726	Wiring Devices
Section 262813	Fuses
Section 262818	Enclosed Switches
Section 263213	Engine Generator
Section 263600	Transfer Switches
Section 264300	Surge Protective Devices
Section 265100	Interior Lighting
Section 265600	Exterior Lighting

DIVISION 27 – COMMUNICATIONS

Section 271005	Structured Cabling for Voice and Data
Section 274110	Audio Visual Systems
Section 275123	Intercommunication System

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section 281300	Access Control System
Section 283111	Building Intrusion Detection
Section 284600	Fire Detection and Alarm System
Section 285500	Rf Survey for Emergency Responder Radio Antenna/ Repeater BDA System

DIVISION 31 – EARTHWORK

Section 312316-13	Trenching
-------------------	-----------

DIVISION 33 – UTILITIES

Section 337119	Electrical Undergrounds Ducts and Transformer Vault
----------------	---

END OF TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 210100 - 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 HVAC and 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 HVAC and plumbing 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 General 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 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.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT AND MATERIALS

- A. Refer to Division 1.

- 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.
- B. The Prime Contractor shall prepare coordination/arrangement CAD drawings for coordination with all other trades. The contractor shall furnish these coordination drawings to the contractor responsible for project BIM coordination.
- C. This Contractor shall obtain approval of all arrangement drawings before continuing with installation of his work.

1.9 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.

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 access panels not shown on the Architectural Reflected Ceiling plans and all 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 Section 08 3113 - "Access Doors and Frames" for specific requirements.

1.19 CUTTING AND PATCHING:

- A. Each Prime 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 Prime Contractors to follow these instructions, 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. 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 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.
- 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.
- 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.
- 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.
- H. Contractor shall seal all piping penetrations through all walls and floors. Penetrations through fire rated walls or floors shall be sealed with an approved UL Listed fire sealant.

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 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.

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, 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. 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 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. The Prime 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.

1.26 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.

1.28 EARTHWORK:

- A. Refer to Division 31 for requirements in addition to the following:
 1. Provide all excavating, backfilling, shoring, sheeting, pumping, bailing, etc., required for the installation of the Work of this Section.
 2. 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.
 3. 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. Refill space below pipe with crushed stone or gravel ranging in size from 1/4" to 3/4".
 4. 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.
 5. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.
 6. 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.
 7. All repair of macadam or concrete paving made necessary by work done under this contract shall be performed by General Contractor at the expense of this contractor. All such repairs shall match surrounding paving in materials and workmanship.

END OF SECTION 210100

SECTION 210101 - 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, sprinklers, or equipment in the existing building which is shown on the Drawings and any additional piping which is in conflict with the new construction work of all trades or new Fire Protection systems. Existing piping and sprinklers 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. Coordinate requirements with Architectural drawings.

1.3 GENERAL:

- A. Modification or removal of existing sprinklers, piping, 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. This contractor shall provide temporary connections where required to keep existing systems operational where required by phasing.
- D. Remove as indicated on the drawings and as required for renovated areas, existing fire protection piping. Cap ends of piping which remain active. Piping which will not remain active shall be removed in its entirety (within accessible areas) or capped and abandoned in place (in inaccessible construction and below slab) unless specifically noted otherwise on the Demolition Drawings.
- E. Cutting and patching shall be by this Contractor unless otherwise indicated.
- F. Asbestos abatement will be performed by the owner's abatement contractor. Should the Contractor find any material that is suspect, he shall report this to the owner's representative immediately. The abatement contractor will schedule the material to be removed.

- G. Remove or disconnect and cap existing piping (as indicated on the drawings) serving sprinklers which are being removed.

END OF SECTION 210101

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 211300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2010.
- C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2011.
- E. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.
- F. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2012.
- G. ASME B16.11 - Forged Fittings, Socket-welding and Threaded; 2011.
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- I. ASME B16.25 - Buttwelding Ends; 2012.
- J. ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2004.

- K. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).
 - L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
 - M. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2009 (Reapproved 2014).
 - N. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
 - O. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2015.
 - P. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).
 - Q. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2013.
 - R. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
 - S. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
 - T. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.
 - U. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.
 - V. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2012.
 - W. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.
 - X. AWWA C606 - Grooved and Shouldered Joints; 2015.
 - Y. FM (AG) - FM Approval Guide; current edition.
 - Z. ITS (DIR) - Directory of Listed Products; current edition.
 - AA. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2013
 - AB. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2013
 - AC. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
- 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 years 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 2015, and IFC 2015, requirements of the Local A.H.J., and minimum requirements as indicated on FP Drawings and Division 21 Specifications.

2.2 BURIED PIPING

- A. Ductile Iron Pipe (3 in. and Larger): AWWA C151/A21.51 cement/mortar lined in accordance with AWWA C104/A21.4
 - 1. Fittings: AWWA C110/A21.10 standard thickness.
 - 2. Joints: AWWA C111/A21.11 rubber gasket.
 - 3. Mechanically Restrained Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

2.3 ABOVE GROUND PIPING

- A. Acceptable Manufacturers for Piping and Tubing:
 - 1. Allied Tube - Sprinkler; 16100 S. Lathrop Avenue, Harvey, IL 60426.
 - 2. Bull Moose Tube Company, 1819 Clarkson Rd., Chesterfield, MO 63017
 - 3. Wheatland Tube Company; 900 Haddon Ave., Collingswood, NJ 08108-2162.
- 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.
 - 1. Dry System Piping - Hot-dipped galvanized to meet FM requirements for dry systems in accordance with the zinc coating specification of ASTM A795 or A53.
- C. Grooved Steel Pipe: Schedule 10 Sprinkler Pipe: ASTM A135, Grade A. UL listed and FM approved for use as sprinkler piping. Black mill coating.
 - 1. Dry System Piping - Hot-dipped galvanized to meet FM requirements for dry systems in accordance with the zinc coating specification of ASTM A795 or A53.
- D. 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, Class 300, 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 manufacturers 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®.
 - 3) Flexible Couplings: Use in seismic areas where required by NFPA 13.
 - (a) 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™.
 - (b) 8" and Larger: Standard flexible coupling. Victaulic Style 75 or 77.
 - (c) Coupling gaskets shall be listed for use as follows:
 - 4) Coupling gaskets shall be listed for use as follows:
 - (a) Dry System(Ambient Temperature) - FlushSeal® or EZ Style 009 design, Grade EPDM, Type A
 - (b) Dry Freezer Applications(-30°F to 0°F) - FlushSeal®, Grade L, Silicone
 - (c) Wet System(Ambient Temperature) - C-Shape or EZ Style 009 design, Grade EPDM, Type A
 - c. Flanged Adapters: ASTM A536 ductile iron casting, flat faced, designed for incorporating flanged components with ANSI Class 150 bolt-hole pattern. Victaulic Style 741.

2.4 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 $\frac{3}{4}$ inches thru $1\frac{1}{2}$ 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.

2.5 GATE VALVES

- A. 2-1/2 inch to 8 inch:
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.

2.6 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.

2.7 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.

2.8 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.
 2. Ductile Iron Body(up to 4 inches)
 - a. 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).

2.9 CHECK VALVES

- A. 2 inch to 3 inch:
 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 inch:

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.

2.10 DRAIN VALVES

A. Ball Valve:

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

2.11 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 size larger than the overall outside diameter of the pipe when insulated.

2.12 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.

2.13 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. All assemblies in painted wall or ceiling applications shall be rustproof and exposed finished edges and surfaces shall be prime-coated with rust inhibitive paint. All assemblies in tiled wall construction shall be stainless steel. Doors shall be flush and shall open 175 degrees on concealed hinges. 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

2.14 ANCHOR BOLTS:

- A. 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.

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 UL Listed fireproof material. The entire penetration assembly shall be UL Listed to achieve fire resistance equivalent to fire separation required for the wall or floor.
- 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 Section 09 9000.
- L. Do not penetrate building structural members unless indicated or as approved in field by Structural Engineer.
- 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

THIS PAGE INTENTIONALLY LEFT BLANK

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. Section 09 9000 - 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 Section 01 3000 - Administrative Requirements, for submittal procedures.
- 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. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 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. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Brady Corporation: www.bradycorp.com.
 - 3. Brimar Industries: www.brimar.com
 - 4. Champion America, Inc: www.Champion-America.com.
 - 5. Kolbi Pipe Markers: www.kolbipipemarkers.com
 - 6. Seton Identification Products: www.seton.com/aec.

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. Valve Tag 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 Section 09 9000, semi-gloss enamel, colors conforming to ASME A13.1.

2.5 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
 - 1. 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. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 - 1. Sprinkler Valves: Black.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Div.1 specifications for stencil painting.

3.2 INSTALLATION

- A. Attach nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Attach tags to all valves with corrosion resistant chain.
- C. Provide additional labelling including but not limited to equipment tags, room labels, etc., for location of equipment and valving as required by the Authority Having Jurisdiction. Coordinate work with Architect in field.
- D. Identify equipment with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- E. Identify valves in main and branch piping with tags. Identify auxilliary drains and any piping specialty required for maintenance and operation of the system with nameplates indicating the function of the specialty.
- F. Tag automatic controls, instruments, and relays. Key to control schematic.
- G. Identify piping, concealed or exposed, with plastic pipe markers or Stencil painting (permitted within mechanical spaces). Verify requirements for exposed piping identification in finished areas with Architect in field. 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.
 - 1. Install plastic pipe markers in accordance with manufacturer's instructions.
 - 2. Apply stencil painting in accordance with Div. 1 specifications.
- H. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 210553

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 211300 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. Sprinkler Heads and Accessories
- C. Supervisory and Monitoring Devices
- D. Sprinkler System Fire Department Connections

1.2 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Fireproofing
- B. Section 21 0500 - Common Work Results for Fire Suppression.
- C. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.
- D. Section 26 2717 - 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; 2013.
- C. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

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.
5. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
6. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
7. 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.
8. Maintenance Materials: Furnish the following spare equipment for Owner's use in maintenance of project.
 - a. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
 - b. Sprinkler Wrenches: For each sprinkler type.
9. 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.

1. Conform to UL requirements.
2. 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.
3. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
4. 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
5. Equipment and Components: Provide products that bear UL label or marking.
6. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

7. 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.
8. To assure uniformity and compatibility of sprinklers within the fire protection system, all sprinkler heads shall be supplied by a single manufacturer.
9. 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-DESIGN MEETING

- A. Coordinate and convene meeting before starting work of this section. Meeting shall include representation from Fire Protection Contractor, Architect, Engineer, AHJ. Meeting shall review general design requirements, submittal requirements, procedures for field coordination with Architect, and field coordination items for local AHJ review.

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-24, and the local Authority Having Jurisdiction.
- B. Testing shall be witnessed by the local Authority Having Jurisdiction and owners 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 System in accordance with IBC and NFPA 13, and inclusive of all additional requirements as indicated on the drawings and in these specifications. The entire building shall be "sprinklered throughout" with "Quick Response" standard coverage sprinklers. No Extended coverage heads shall be permitted except where specifically noted on the Fire Protection drawings. The Fire Suppression Sprinkler System shall be hydraulically calculated to provide the prescribed density uniformly over the most remote area in accordance with NFPA13 and include a minimum 10psi safety factor.
 - 1. Occupancy: Building predominantly Light Hazard, some areas of other classification in accordance with NFPA 13 and document drawings.
- B. Interface system with building control system.
- C. Provide Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

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. Coordinate testing with local Water Authority.
- B. Submit water flow test data with Hydraulic Calculations

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. General:
 - 1. UL and FM approved. Die-cast brass frame to 65-30, bronze upright or pendant deflector, beryllium nickel spring, with stainless steel lodgement spring and teflon tape seal. Glycerin filled glass bulb, rated for working pressure to 175 psi . Where corrosion resistant construction is required by specifications or drawings, body shall be coated with UL listed and FM approved anti-corrosion nickel teflon coating, (VC-250 - silver coloring). The sprinkler body shall be cast with hex shaped wrench boss to reduce the risk of damage during installation. Sprinklers can be ordered with NPT or IGS grooved connections. Sprinklers shall not contain rubber O-rings. Quick response type.
- C. Concealed Pendant Type (with matching push on escutcheon plateSuspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:

1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 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).
- D. Dry Concealed Pendant Type (with matching push on escutcheon plate Suspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 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. Galvanized steel dry barrel with stainless steel inner tube
 5. Design Basis: Victaulic Model V33 series (Quick Response).
- E. Dry, Flexible Style, Concealed Pendent/ Pendent/ Horizontal Sidewall Type (with matching push on escutcheon plate Suspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 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. Flexible hose: UL listed FM approved SS braided hose
 5. Design Basis: Victaulic Model V35 series (Quick Response).
- F. Standard Upright or Pendent type, with guard (Exposed Sprinkler Areas) - Quick Response
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 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).
- G. Dry Standard Upright, with guard (Exposed Sprinkler Areas) - Quick Response
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)

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. Galvanized steel dry barrel with stainless steel inner tube
 4. Design Basis: Victaulic Model V36 series (Quick Response).
- H. Dry Standard Pendant, with guard (Exposed Sprinkler Areas) - Quick Response
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 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. Galvanized steel dry barrel with stainless steel inner tube
 4. Design Basis: Victaulic Model V36 series (Quick Response).
- I. 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 NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 4. Design Basis: Victaulic Model V27 series (Quick Response).
- J. Dry Pendant Sprinklers (Within walk in coolers/Freezers): Quick Response, Dry pendant type with matching escutcheon plate.
1. Finish: Chrome plated.
 2. Escutcheon Plate Finish: Chrome plated factory assembled.
 3. Fusible Link: Glass bulb type temperature rated for specific area hazard.
 4. Design Basis: Victaulic Model V36 series (Quick Response) with Integral AB6 assembly.
- K. Guards: Finish chrome.
- L. Flexible sprinkler connections: In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System [with captured coupling Style 108] 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 steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
1. Captured Coupling IGS Groove Style 108: Single-bolt, consisting of two ductile iron housings, Grade E “EPDM” gasket, and a zinc electroplated steel bolt and nut conforming to ASTM A449.

2. 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 be listed for (5) bends at 36" length, (7) bends at 48" length, (9) bends at 60" length and (10) bends at 72" length.
3. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed for sprinkler services to 175 psi. and and FM Approved to 200 psi.
4. All hoses shall be factory-pressure tested to 400 psi.
5. AB6 Bracket Assembly, for use in cold storage applications with Victaulic Model V36 dry sprinklers.
6. Approvals:
 - a. FM-1637
 - b. UL 2443
7. Refer to the Victaulic I-VICFLEX installation manual and the Victaulic VicFlex™ Design Guide, as shown in product submittal 10.85 to ensure proper installation.

2.4 ELECTRIC HORN/STROBE

- A. Acceptable Manufacturers
 - *All electric notification devices shall be provided by from a single manufacturer.
 1. SimplexGrinnell.
 2. Wheelock.
- B. U.L. listed, Weatherproof A/V horn/strobe, red cover with white lettering, regulated 24 DC, with weatherproof mounting box.
 1. Design Basis: SimplexGrinnell True Alert Model 4906-9131 w/Model 4905-9828 weatherproof box.
- C. Coordinate exact location and mounting with Local AHJ and coordinate required wiring to fire alarm panel with E.C. in field.

2.5 WATER FLOW SWITCH

- A. Acceptable Manufacturers
 - *All flow, pressure and supervisory switches shall be provided by from a single manufacturer.
 1. Potter Roemer.
 2. System Sensor.
- B. 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.

2.6 SUPERVISORY SWITCH

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design and provide fire suppression system in accordance with all referenced standards and local codes.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Provide Fire Department Connections (FDC) at locations indicated on plans. Verify all Fire Department Connection details including style, connection type, height above grade, size, threads, and signage with local Fire Marshal or Fire Department prior to order/installation.
- D. Locate outside horn strobe alarm on building wall above all fire department connections, outside room containing the fire protection service entrance valving, and as indicated on plans.
- E. Place pipe runs to minimize obstruction to other work.
- F. Provide penetration firestopping for all work of Div. 21 in accordance with Div. 07 specifications.
- G. Field coordinate all exposed piping in finished spaces with Architect prior to fabrication or installation of piping. This field coordination of proposed pipe routing shall include on site review of submittal drawings with Architect and any other trades affected by the work.
- H. In areas with finished ceilings, place piping in concealed spaces above finished ceilings. Coordinate piping locations between all trades prior to installation and final design. In exposed structure areas, all pipe routing shall be reviewed in field with Architect for final approval prior to installation of any work.
- I. 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.

- J. Align sprinklers symmetrically with other ceiling fixtures and elements as shown on approved architectural reflected ceiling plans.
- K. 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.
- L. Flush entire piping system of foreign matter.
- M. Install guards on all exposed sprinklers except where noted otherwise.
- N. Provide system tests at locations as required by NFPA-13. Pipe all system test drains to building exterior in location approved by Architect , Owner , and AHJ.
- O. Hydrostatically test entire system in accordance with NFPA-13. Coordinate testing to be witnessed by Fire Marshal and authority having jurisdiction.
- P. Provide system training for Owner representatives to include required maintenance, system supervisory devices, operating equipment, etc.
- Q. Provide identification for sprinkler system components and piping in accordance with Section 210553. Provide riser tags including hydraulic calculation information at all riser alarm valves and floor control assemblies
- R. Provide laminated color coded Zone Maps to be displayed at main building fire alarm panel Indicating fire sprinkler zones and control locations. Coordinate all requirements with local Fire Marshal prior to installation.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system. Coordinate work between all trades.

3.3 SCHEDULES

- A. System Hazard Areas:
 - 1. Lobby/Vestibules, Offices, Corridors, Meeting/Conference Rooms, Toilet rooms, and similar spaces: Light Hazard.
 - 2. Mechanical Room, Storage Spaces, Janitors Closets, Mail Rooms, and similar spaces: Ordinary Hazard, Group 1.

END OF SECTION 211300

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 220100 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified in this section. These General Provisions are in addition to all requirements of Division 01 specifications. Where requirements of this section are in conflict with the requirements of Division 01 specification requirements, the requirements of Division 01 take precedence.

1.2 DESCRIPTION OF WORK:

- A. Work covered by this Division of the Specifications shall consist of the furnishing of all material, equipment, apparatus, tools, and labor and installation services required to provide the mechanical systems, such as they are specified and shown, in an acceptable operating condition.
- B. General description of the work associated with each major classification of mechanical work is included in the Scope of the Work in various Sections. Other items of mechanically related work are shown on the mechanical drawings.
- C. Contractor shall provide all labor and materials that may be required, or as directed, to test, adjust, retest and readjust the mechanical systems in order for them to operate satisfactorily. Architect shall determine what is satisfactory.
- D. Contractors shall visit the site during the bidding period and become familiar with all of the existing conditions, which could influence the work in the Contracts.
- E. Refer to Division 01 specifications and Summary of Contracts for additional requirements.

1.3 CONTRACTOR:

- A. The term Contractor as used in the Specifications shall be understood to mean the people or firm awarded the Contract for the respective phases of work

1.4 DRAWINGS:

- A. The Heating, Ventilating, Air Conditioning, Fire Protection and Plumbing Systems are indicated on the respective Plans, but attention is called to the fact that certain pertinent information and details may appear on Architectural Plans, and these will become a part of each Contract. The Architectural and Mechanical/Electrical/Plumbing Plans are intended to be complimentary. In the event of any discrepancies between them or between any of the Plans and these Specifications, the Architect shall be

notified promptly and will issue his interpretation to all interested parties. So far as arrangement of equipment, fixtures, and appurtenances to conform with construction conditions is concerned the Architectural Plans and Details shall govern, rather than the MEP Drawings.

1.5 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.

1.6 DEFINITIONS:

- A. Where the word "provide" is used in connection with a system, equipment, or an item it shall be understood to mean the furnishing and installing of the system, equipment or item on this project.
- B. Where the phrase "as directed" is used, it shall be understood to mean as directed or instructed by the Architect or his authorized representative.
- C. Where the word "shall" appears in these Specifications, it shall be understood to mean that the labor, material or performance which it describes, or is associated, is mandatory.
- D. Where the words "to be" appear in these Specifications, it shall be understood to have the same interpretation as if the word "shall be" were inserted in their place.
- E. Where the word "comparable" appears in these Specifications, it shall be understood to mean that any item of equipment or material which is specified with an absolute minimum of differences.

1.7 VISIT TO SITE:

- A. Attention is directed to the necessity for all the various Contractors to visit the site and examine all conditions affecting the proper execution of their Contracts. 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 Mechanical Contractors for extra work caused by failure to visit, examine and clarify.

1.8 LINES, GRADES AND SURVEYS:

- A. All necessary surveys, lines, grades and measurements are the responsibility of the Contractor desiring the information for the proper installation of his work. The Contractor shall verify all lines, grades and dimensions as shown on the Drawings. The Contractor will verify all lines and grades with the local controlling agency.
- B. Grades, elevations, and locations shown on the Drawings are approximate and the Contractor shall verify all such information on the site before proceeding with the work.

1.9 METHOD OF PROCEDURE:

- A. The Drawings accompanying these Specifications are diagrammatic and intended to indicate the approximate and relative locations of the Mechanical and Plumbing Systems.
- B. Installation, connection and inter-connection of all components of the Mechanical and Plumbing Systems shall be complete and made in accordance with the manufacturer's instructions and best practices of the respective trades.
- C. Each Contractor shall erect all parts of equipment to be furnished under his Contract at such time and in such manner as not to delay or interfere with any Contractor performing work at that time.
- D. The Contractor shall coordinate their work with all other Contractors as to the locations of different lines of pipe, ducts, conduit, and electrical equipment before erecting any work, so as to avoid interference or conflicts. In case of conflict, equipment/piping shall be relocated, without additional cost to the Owner, as directed by the Architect regardless of which equipment/piping was installed first. Each Contractor shall cooperate with other Contractors for the proper securing and anchoring of all work included within these Specifications.
- E. Extraordinary care shall be used in the erection and installation of all equipment and materials to avoid marring surfaces of the work of other Contractors, as each Contractor will be held responsible for all such damage caused by the lack of precaution and due to negligence on the part of his workmen.

1.10 LAWS, ORDINANCES AND REGULATIONS:

- A. All Plumbing Systems in all and/or part shall conform to all pertinent laws, ordinances and regulations of ALL bodies having jurisdiction, at all governing levels, notwithstanding anything in these Plans or Specifications to the contrary. In case of conflict between governing levels, the more stringent laws shall apply.
- B. Each Contractor shall refer to Division 01 specifications for permit and fees responsibilities required for completion of their work. Certificates of completed inspections required by the Authority Having Jurisdiction, and these specifications, shall be delivered to the Architect. Final payment is contingent upon delivery of such Certificates to Architect.

1.11 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.

1.12 CONCRETE AND MASONRY WORK:

- A. Contractor shall furnish and install all concrete bases, reinforcing, etc. required to install the Plumbing Work, unless otherwise noted.
- B. Prior to installing any forms, reinforcing or concrete, the Contractor 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.

1.13 MATERIALS AND EQUIPMENT:

- A. All materials and equipment shall be new, and shall conform to the grade, quality and standard specified herein. All materials and equipment utilized shall be manufactured in the United States of America.
- B. All equipment offered under these Specifications shall be limited to products regularly produced and recommended for service, in accordance with engineering data, rating, or other comprehensive literature made available to the public and in effect at the time of opening of bids.
- C. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. These Contractors shall obtain these instructions, which shall be considered part of these Specifications. Type, capacity and application of equipment shall be suitable and shall operate satisfactorily for the purpose intended in the respective Mechanical Systems.
- D. Equipment shown on the Drawings illustrates the general space requirements and each Contractor shall install only such equipment, which shall not necessitate changes in the building or arrangements. If changes are required due to substitution the contractor shall pay ALL costs stemming from such change. No such changes shall be made except with Architect's written approval.

1.14 ANCHOR BOLTS:

- A. 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.

1.15 NOISE AND VIBRATION:

- A. Particular care shall be exercised in the selection and installation of all 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.
 - 1. 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.
 - 2.

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

1.16 SOUND ISOLATION:

- A. All equipment and piping shall be installed so that no noise or vibration is transmitted to any part of the building beyond the room or rooms in which such noise or vibration is generating. Moving equipment shall be isolated from the concrete foundations or floors by cork where required to prevent transmission of noise or vibration.
- B. Silencers shall be installed in water connections to quick closing devices. Shock absorbers shall be used in all pipe lines where required to eliminate noise.
- C. Any and all other insulation or isolation required to accomplish the results specified above shall be furnished and installed without additional cost to the Owner.

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.

1.18 ACCESS DOORS AND PANELS:

- A. Refer to Section 08 3113 - "Access Doors and Frames" for specific requirements. Where requirements are not specified in Section 08 3113, the following requirements of this section shall apply.
- B. 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 valves, specialties, and other serviceable items are installed behind plaster, tile, or similar type non-removable surfaces.
- C. 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. All assemblies within painted walls or ceilings shall have all exposed finished edges and surfaces prime-coated with rust inhibitive paint. All assemblies within tiled wall areas shall be constructed of 304 Stainless steel or equivalent. 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. Each Prime Contractor shall give the General Contractor and/or the Construction Manager 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 individual Prime Contractors to follow these instructions, the respective Prime 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.
 - 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.
 - 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.
 - F. All cutting in the building shall be done with great care so as not to leave an unsightly surface which may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through the fault of the Prime Contractor, he shall be required at his own expense, to engage the General Contractor to replace the damaged materials with new materials.
 - G. 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.
 - H. 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.
 - I. Contractor shall seal all piping penetrations through all walls and floors. Penetrations through fire rated walls or floors shall be sealed with an approved UL Listed fire sealant.
- 1.20 ANCHORS:
- A. Direct all pipe motion to expansion bends, loops, or joints by heavy pipe clamps and/or structural steel sections welded to pipe lines and clamped or welded to structural members as directed by the Architect. Points at which anchors are located and secured shall be approved by the Architect so that no structural members shall be unduly strained. Where possible, anchor points shall be on members running parallel to the piping being anchored.

1.21 FLASHING:

- A. Soil and vent stacks shall be installed as detailed on the Drawings. Base of flashing shall be at least 24 inches square. All Flashing material and installation shall be in accordance with all requirements and recommendations of the roofing installer and roofing manufacturer to maintain any roof warranty.

1.22 PRESSURE VESSELS:

- A. All tanks subjected to pressure shall conform to A.S.M.E. Code and the regulations of the controlling State Agencies. They shall bear the stamp of A.S.M.E. Test Code Compliance and National Insignia Number and the required stamp of any controlling State agency.

1.23 STORAGE:

- A. Each Contractor shall provide suitable storage facilities in the location assigned him at the site for his materials. Where parts of the building are used for such storage, they shall be left in condition satisfactory to the Architect.
- B. All materials delivered on the premises or materials stored at the Contractor's place of business or in warehouses, which are to form a part of the work and for which the Contractor has submitted an application for payment, shall be considered the property of the Owner and shall not be removed, sold or used for other purposes without his consent.
- C. The Contractor has the right to remove all his surplus materials after completion of the work.

1.24 RUBBISH REMOVAL AND CLEAN-UP:

- A. Each Contractor is responsible for periodic removal of all rubbish resulting from his work. All surplus material, refuse, rubbish etc., shall be removed from the job site at completion of Contract. The Architect must be satisfied with the removal and clean-up.

1.25 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 Contractor, the Plumbing Contractor shall perform the work in conformance with Electrical Specifications for this project.

1.26 TESTS:

- A. The following requirements are supplementary to test specified for individual equipment or systems in Mechanical Sections.
 - 1. Written notice of date of test shall be given in ample time to all concerned.

2. Concealed or insulated work shall remain uncovered until required tests have been completed. However, if construction schedule requires, arrange for prior test on parts of the system.
3. As soon as conditions permit, conduct preliminary test of equipment to ascertain compliance with specified requirements. Make needed changes, adjustments or replacements as preliminary tests may indicate, prior to acceptance test.
4. Conduct pressure, performance, and operating tests as specified or required for each system or equipment unit in presence of Architect, as well as representatives of agencies having jurisdiction.
5. Each Mechanical Contractor shall furnish labor, material, and instruments and shall bear all other costs in connection with tests.
6. Obtain certificates of approval and/or acceptance in compliance with regulations of agencies having jurisdiction. Work shall not be deemed complete until such certificates have been delivered to the Owner.
7. Each Contractor shall instruct representatives of Owner in all details of operation and maintenance of systems installed under these Contracts. Such instruction shall continue as long as necessary or as directed.
8. Testing shall prove conclusively that all Mechanical Systems operate properly, efficiently, and quietly in accordance with the letter and the intent of the Drawings and Specifications.

1.27 PROTECTION:

- A. Each Contractor shall effectively protect his work and materials with tarpaulins of heavy plastic material against dirt, water, chemicals, plaster, or damage during the whole period of installation or until he is directed to remove the coverings by the Architect. Any damaged material must be removed and replaced by the Contractor without additional cost regardless of the cause of the damage. All openings in pipes, fittings, ductwork, conduit, etc., must be effectively sealed to exclude dirt, sand, and other foreign substances.
- B. In areas where the wall finish consists of ceramic tile, metal fittings shall not be installed until the walls have been acid cleaned.

1.28 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship. The guarantee period shall be as specified in Division 01 specification sections, beginning from date of final acceptance and turnover to Owner. 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.

1.29 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.

1.30 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.

1.31 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS:

- A. Refer to Div. 01 specifications for for specific requirements. Where requirements are not specified in Section Div. 01, the following requirements of this section shall apply.
- B. Shop drawings and equipment submittals shall be submitted to and be approved by the Architect before any work is accomplished. They shall clearly indicate the location, service and function of each particular item. Submittals shall be in the form of manufacturers printed catalogs, pamphlets, for which approval is requested. Identification of model to be supplied and all options shall be made in ink. Shop drawings and submittals shall both be completely referenced and identified. Descriptive information and data on submittals shall be complete. Those drawings and submittals, which only show partial or general information will not be acceptable and will be returned to the Contractor.
- C. Contractor shall include in writing, any deviations in the submittals and shop drawings where such deviations are a departure from the Contract Documents. This written advisory shall accompany the initial submittal and shall state the reasons for the deviations.

- D. Shop drawings and submittals which are to be prepared by the various subcontractors and equipment suppliers shall first be sent to the Contractor for checking and eventual formal submission to the Architect. Contractor shall check these drawings and submittals with respect to measurements, materials, identifications, and details so as to make certain that they conform to the intent of the Contract Documents. Drawings and submittals which are found to be inaccurate or otherwise in error shall be returned by the Contractor to originating party for correction before submission to the Architect for approval.
- E. Architect/Engineer shall check the shop drawings and submittals to see if they conform with the design concept for this project and whether they comply with the information given in the Contract Documents. Contractor shall be responsible for dimensions that are to be confirmed and correlated at the job site, for coordination in the ordering and assembly of mechanical equipment, for information that pertains solely to fabrication processes or to techniques of construction, and for coordination of the work of all trades.
- F. The following specific items and information shall be included:
1. All optional accessories as specified in the specifications and drawings clearly noted.
 2. Capacity and performance data as shown on the Equipment Schedules or as specified. Complete descriptive data on the equipment so that compliance with the Specifications can be ascertained.
 3. Submittals for all valves, specialties, and miscellaneous items which are specified, scheduled, or shown.
 4. Electrical wiring diagrams (power and control) that show the complete control of electric motor driven equipment which is to be furnished by Division 15.
- G. Plumbing systems and equipment which have been installed without having been previously approved by the Architect/Engineer may be condemned by him. They shall be removed if so condemned and be replaced with systems and equipment that are approved. This work shall be done without any additional cost to the Owner.
- H. Shop drawings and equipment submittals shall be revised as often as may be necessary in obtaining the Architect/Engineer's approval. Only equipment submittals and shop drawings for the installation of systems shall be used at the construction site which have Architect/Engineers stamp of approval. Contractor shall not install any equipment or materials in this contract unless they have been previously approved by the Architect/Engineer. Contractor shall not delay the progress of the work by resorting to unnecessary delays in resubmitting shop drawings or submittals for approval.
- I. When they have been rejected or have been returned for additional information, no longer than 3 weeks shall elapse between receipt of returned material and the resubmittal of revised or new information. Architect/Engineer shall have the option of canceling the Contractor's privilege of substituting materials and equipment if there is evidence of flagrant abuse of this equipment.
- J. It is suggested that the Contractor obtain from his various equipment suppliers, at the time that shop drawings and submittals are prepared, all of the information that will ultimately be required for the Maintenance and Operating Manual.

1.32 SUBSTITUTIONS:

- A. Refer to Div. 01 specifications for for specific requirements. Where requirements are not specified in Section Div. 01, the following requirements of this section shall apply.
- B. Various items of equipment, fixtures, and materials that have been used as the Design Basis for the Plumbing system design, and have been specified by a manufacturer's name and model number. Substitutions of another manufacturer's product must be submitted in accordance with the substitution procedure outlined in the Division 01 specifications at time of bidding. In addition to the requirements of the Div. 01 specifications, substitution requests must contain a line item breakdown of all specified performance materials and requirements of the specified basis of design fixture/equipment. The Architect/Engineer 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. Contractor 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 verify that substitute equipment/fixture, will fit into the designated spaces. Contractor 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. Refer to Division 01 specifications for additional Substitution requirements.

1.33 ALTERNATES:

- A. Refer to Div. 01 specifications for for specific requirements. Where requirements are not specified in Section Div. 01, the following requirements of this section shall apply.
- B. 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. The Contractor 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. The Contractor 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.

1.34 ALIGNMENT/COORDINATION:

- 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, 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 resulting in relocation of ceiling components, as directed by the Architect, shall be completed at the Contractor's expense.

1.35 NOTICE TO SUBCONTRACTORS:

- A. The General Conditions, Special and Supplementary Conditions preceding the General Contract Specifications and all other Contract requirements herein apply in full to the Prime Contracts and/or subcontracts as though inserted here. The Contractor's and subcontractor's attention is called to these sections.
- B. No extra compensation will be allowed because of the failure of the Prime Contractors and their subcontractors to be fully acquainted with these Documents.

1.36 FINISHED AND UNFINISHED AREAS:

- A. Finished area shall be defined as any space with the walls either tiled, plastered, covered, or painted. Where there are ceilings in finished areas, all piping, conduit, ductwork, etc., shall be concealed above the ceiling unless specifically indicated to be exposed.
- B. Unfinished areas shall be defined as any space without a wall finish.
- C. Where in doubt as to the classification of a specific space, the Contractor shall check with the architect before roughing.

1.37 RECORD 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 pipe sizing, location, and details.
- B. At the completion of the work, the Contractor shall forward these prints to the Architect.
- C. Locations of all piping and conduits located underground (either below the building floor slab or outside the building) shall be dimensioned so that their exact location can be determined. These dimensions shall be recorded on a set of prints and shall be forwarded to the Architect.

1.38 OPERATION AND MAINTENANCE INSTRUCTIONS:

- A. Refer to Div. 01 specifications for for specific requirements. Where requirements are not specified in Section Div. 01, the following requirements of this section shall apply.

- B. Upon the completion of this project, the Contractor shall deliver to the Architect for approval, an operating and maintenance manual in accordance with Division 01 specification sections.
- C. 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.
- D. 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. In addition to the requirements of Division 01 specification sections 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 trouble shooting 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.
- E. All of the materials shall be indexed, arranged categorically and be submitted as indicated in the Division 01 specification sections.

1.39 OSHA STANDARDS:

- A. The Contractor's attention is called to his sole responsibility in regards to the Occupational Safety and Health Administration Standards. All construction work shall be performed in strict accordance with these Standards.
- B. The permanent installation shall meet the requirements of the OSHA Standards. All purchased equipment shall be designed, manufactured, and trimmed with the necessary accessories to meet or exceed the OSHA requirements. Any field constructed facilities - ladders, platforms, guardrails, safety features, and the like - shall be as recommended in the OSHA Standards.
- C. No additional costs shall be charged to the Owner for work required to meet OSHA regulations. Any discrepancy between these Plans and Specifications and the OSHA Standards shall be brought to the attention of the Architect for resolution before the work is commenced.

1.40 PAINTING:

- A. Prime contractor shall paint materials used in installation of the work of their contract in all unfinished and exterior areas as specified below.
- B. Paint all metal laid underground with one heavy coat of corrosion protective materials.
- C. Paint all ferrous piping exposed to atmosphere or other corrosive environments with corrosion inhibiting prime coating and one coat enamel paint upon installation.

1.41 CONCRETE PADS:

- A. Provide concrete housekeeping pads for all floor mounted plumbing equipment, and dowel into the slab. Provide dowels as directed by Structural Engineer.
- B. Provide hook type anchor bolts of proper size and length to suit the equipment. Set bolts in pipe sleeves 1" larger than bolt diameter and half the embedded length of the bolt.
- C. Where concrete pads are provided, prepare dimensioned drawings showing exact size and location. Distribute drawings to interested parties as directed by Architect.

1.42 EARTHWORK:

- A. Provide all excavating, backfilling, shoring, sheeting, pumping, bailing, etc., required for the installation of the Work of this Section.
- B. 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. Concrete or other approved supports shall be provided for all pipes installed in fill.
- C. 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. Refill space below pipe with compacted crushed stone or gravel ranging in size from 1/4" to 3/4".
- D. 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.
- E. Refer to the plumbing details for additional earthwork requirements.

1.43 CODES, ORDINANCES, AND FEES:

- A. Installation of all work shall be done in strict accordance with all applicable local ordinances, local regulations, and state statutes. In case of conflict, the code having immediate jurisdiction shall govern. Methods to be used in the installation of equipment and materials shall not be construed to permit deviation from the requirements of governing codes.
- B. Contractor shall obtain all permits and shall arrange for all inspections that may be required in connection with the work. All fees shall be paid by the Contractor. Work shall be done in accordance with, but not limited to, the applicable sections of the latest edition and supplement to the following codes and Standards:
 - 1. Building/Plumbing Ordinance as interpreted by the Building/Plumbing Inspector.
 - 2. Sprinkler Systems; NFPA 13.
 - 3. National Fuel Gas Code; NFPA 54.
 - 4. Boilers; NFPA 85.
 - 5. Chimneys and Vents; NFPA 211.
 - 6. National Electric Code, NFPA No. 70.
 - 7. NEMA Standard which pertain to motors, motor starter, control panels and wiring devices that are furnished as an integral part of items of mechanical equipment.
- C. It shall be understood that the ANSI Standards and ASTM Specifications that are referred to in this Division are intended to be the current edition of each.

1.44 DEMONSTRATIONS AND SPARE PARTS:

- A. The following is a list of equipment and systems that need to be demonstrated to the Owner and his representatives by either the installing Contractor or a factory representative.
- B. The Contractor shall coordinate with the Owner the exact day and time the demonstrations will take place. Sufficient notice shall be given, so the Owner may have the proper personnel available to receive the demonstrations. It is strongly recommended the Contractor obtain signatures from those in attendance that they received the demonstrations and instructions. A copy of the O & M shall be on-site during the demonstration. Each demonstration shall be videotaped and the tape shall be turned over to the Owner for future reference.
- C. Following is a list of common items requiring demonstration. Demonstrations shall not necessarily be limited to this list.
 - 1. Date of Demonstration: _____ By: _____
 - 2. Plumbing
 - a. Water Heater(s)
 - b. Mixing Valves
 - c. Recirculation Pumps and systems
 - d. Grease Interceptors
 - e. Plumbing Fixtures & Trim

1.45 CLOSE OUT DOCUMENTS

- A. Each Contractor shall submit the following Close-out Documents and obtain receipts for them:
 - 1. Record Drawings including dimensioned drawings showing underground lines.
 - 2. Operation and Maintenance Manuals.
 - 3. Booklet with list of all spare parts supplied.
- B. Refer to Division 01 for additional close out documentation requirements.

1.46 COMMISSIONING

- A. The Contractor shall provide all work required for the commissioning of all systems within his scope of work and time required for operational demonstrations of the systems. Contractor shall coordinate all commissioning requirements with G.C.

END OF SECTION 220100

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 220101 - 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, or equipment in the existing building which is shown on the Drawings and any additional piping which is in conflict with the new construction or new Plumbing systems. Existing piping and supplies for equipment and fixtures 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. Coordinate requirements with Architectural drawings.

1.3 GENERAL:

- A. Modification or removal of 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. This contractor shall provide temporary connections where required to keep existing systems operational where required by phasing.
- D. Remove as indicated on the drawings and as required for renovated areas, existing waste, vent, water, gas, and storm water piping. Cap ends of piping which remain active. Piping which will not remain active shall be removed in its entirety (within accessible areas) or capped and abandoned in place (in inaccessible construction and below slab) unless specifically noted otherwise on the Demolition Drawings.
- E. Cutting and patching shall be by this Contractor unless otherwise indicated.
- F. Asbestos abatement will be performed by the owner's abatement contractor. Should the Contractor find any material that is suspect, he shall report this to the owner's representative immediately. The abatement contractor will schedule the material to be removed.

- G. Remove or disconnect and cap existing piping (as indicated on the drawings) serving plumbing fixtures which are being removed.
- H. Carefully disconnect all fixtures which are to be replaced with new like in kind fixtures such that the original rough in can be reused. Contractor shall replace damaged connections or rough in supplies where necessary to reconnect new fixtures. Contractor shall provide all required new hardware for mounting and reconnection of new fixtures.

END OF SECTION 220101

SECTION 220502 - EXCAVATION, BACKFILL & COMPACTION FOR UTILITY TRENCHES

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 Contractor. 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 to Utility personnel 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. Quality Control testing During Construction: Contractor shall coordinate with Owner's testing laboratory 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) 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 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 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 per foot of backfill and one test for each 50 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 that have been placed are below specified density, perform additional compaction and testing until specified density is obtained. trenching and backfilling operations with 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.

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

THIS PAGE INTENTIONALLY LEFT BLANK

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.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - 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 Section 01 6000 - Product Requirements. for additional provisions.
- B. Supply two spare gauges of each type and pressure range installed.

- C. Supply two spare thermometers of each type and pressure range installed.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

- A. Manufacturers:
1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 2. Moeller Instrument Co., Inc: www.moellerinstrument.com.
 3. H.O. Trerice: www.trerice.com
 4. Omega Engineering, Inc: www.omega.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- 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. Pressure gauges installed in domestic water piping shall conform with the Lead free requirements of the Safe Water Drinking Act and NSF-372.
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.
 6. Basis of Design: H.O. Trerice Model 620B

2.2 PRESSURE GAGE TAPPINGS

- A. Isolation valve: provide gage tapping valve
1. Gage Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Pressure Snubber
1. Lead Free Brass, NSF-61 compliant, connection size to match gauge connection

2.3 STEM TYPE THERMOMETERS

- A. Manufacturers:
1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 2. Omega Engineering, Inc: www.omega.com.
 3. H.O. Trerice: www.trerice.com
 4. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Thermometers - Adjustable Angle: Red- or blue-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. Thermometers installed in domestic water piping shall conform with the Lead free requirements of the Safe Water Drinking Act and NSF-372.
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.
6. Basis of Design: H.O. Terrice Model BX9-403

2.4 PORTABLE TEST KIT/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.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapters with 1/8 inch probes, two 1 inch dial thermometers.

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 riser.
- 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.

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. Stem Type Thermometers, Location and Scale Range:
1. Domestic hot water supply and recirculation, 0 to 200 degrees F.

END OF SECTION 220519

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. Labelling 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 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. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Brady Corporation: www.bradycorp.com.
 - 3. Brimar Industries: www.brimar.com
 - 4. Champion America, Inc: www.Champion-America.com.
 - 5. Kolbi Pipe Markers: www.kolbipipemarkers.com
 - 6. Seton Identification Products: www.seton.com/aec.

2.2 NAMEPLATES

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

2.3 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.

2.4 PIPE MARKERS

- A. Comply with ASME A13.1.
- B. 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.

2.5 UNDERGROUND PLASTIC PIPE MARKERS:

- A. 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.

2.6 CEILING TACKS

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

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.

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. Plastic pipe markers, with application system as indicated under "Products" in this section.
 3. 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.
4. 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, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. 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.
 3. Provide valve finder ceiling dots at all concealed valve locations. Locate on ceiling grid not on ceiling tile.
- C. Mechanical Equipment Identification:
1. General: Install engraved plastic laminate nameplate 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.
 - c. Domestic water heaters
 - d. Domestic water pressure booster pumps
 - e. Recirculation pumps
 - f. Water Softeners
 - g. Sewage and Stormwater ejectors

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.

1.2 RELATED SECTIONS

- A. Section 078400 - Firestopping.
- B. Section 099000 - 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. IECC - ICC - International Energy Conservation Code
- I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

1.4 SUBMITTALS

- A. See Division 01 specifications 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. Substitutions: See Section 016000 - Product Requirements.
- 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.

- C. Insulation: ASTM C 547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' value: ASTM C 177, 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.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Vapor Barrier Lap Adhesive:
 - 1. Compatible with insulation.
- G. Insulating Cement/Mastic:
 - 1. ASTM C 195; hydraulic setting on mineral wool.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell International: www.armacell.com.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Type I, Tubular Grade 1; ASTM E 84/ UL 723 25/50 rated for use in return air plenums, use molded tubular material wherever possible. ArmaFlex Ultra or approved equal.
 - 1. Thermal Conductivity: 0.27 Btu-in/hr-ft²-degF @ 75 deg.F Mean Temp
 - 2. Minimum Service Temperature: -40 degrees F.
 - 3. Maximum Service Temperature: 220 degrees F.
 - 4. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 PLENUM INSULATION

- A. Manufacturer
 - 1. Unifrax Corporation
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: Fyrewrap .5 plenum insulation, high temperature, biosoluble insulation, aluminum foil/fiberglass reinforced scrim encapsulated

2.5 JACKETS/SHIELDS

- A. PVC Plastic.
 - 1. Manufacturers:

- a. Johns Manville Corporation: www.jm.com.
 - b. Substitutions: See Section 016000 - Product Requirements.
 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. Stainless Steel Jackets
1. Standards:
 - a. ASTM-A240 and A666 Standards
 2. Thickness
 - a. .016" (.4mm)

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.
- F. For hot water piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

- G. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. 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.
 - 2. 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.
- H. 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.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.
- J. Exposed Insulated Pipe (from floor penetration to 10 feet above finished floor): Provide with Stainless Steel jacket around entire pipe/insulation circumference
- K. Provide UL listed plenum insulation on all piping not conforming to the 25/50 smoke and flame requirements for combustibility as required by the International Mechanical code, and installed within return air plenum spaces.

3.3 SCHEDULES

- A. Plumbing Systems: (Provide insulation for piping and appurtenances of the following Plumbing systems as scheduled below)
 - 1. Domestic Cold Water Supply:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness:
 - (a) All pipe sizes: 1-inch thick
 - b. Flexible Elastomeric Cellular Insulation (underground piping, piping installed in masonry walls):
 - 1) Thickness:
 - (a) All pipe sizes: 1-inch thick
 - 2. Domestic Hot, Hot Return, 140F Hot, and 140F Return Water Supply:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness:
 - (a) Pipe sizes up to and including 1-1/4-inch: 1-inch thick
 - (b) Pipe sizes 1-1/2"-inch - 6"-inch: 1-1/2 inch thick
 - b. Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in masonry walls):

- 1) Thickness:
 - (a) Pipe sizes up to and including 1-1/4-inch: 1-inch thick
 - (b) Pipe sizes 1-1/2"-inch - 6"-inch: 1-1/2 inch thick
3. Tempered Domestic Water Supply:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness::
 - (a) All pipe sizes: 1-inch thick
4. Non-Potable Water:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness::
 - (a) All pipe sizes: 1-inch thick
 - b. Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in concrete walls):
 - 1) Thickness:
 - (a) All pipe sizes: 1-inch thick
5. Roof Drain and Emergency Roof Drain Bodies:
 - a. Glass Fiber Insulation:
 - 1) 1-inch thick for Glass Fiber
 - (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 jacket is required (color selected by Architect).
6. Rainwater and Emergency Rainwater Drainage Piping Above Grade (all horizontal and all vertical piping):
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Pipe Size Range:
 - (a) all pipe sizes: 1-1/2 -inch thick
7. Cold Condensate Drains:
 - a. Flexible Elastomeric Insulation:
 - 1) 1-inch for all pipe sizes.

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. 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 including final coordination and connection to Site Sanitary system.
 - 2. Domestic Potable Water.
 - a. 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 Site Water supply.
 - 3. Rainwater/Storm Water & Emergency Rainwater.
 - a. 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 including final connection to Site Storm water system.
 - 4. Condensate Drain Piping

1.2 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Fireproofing
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 09 9000 - Painting and Coating.
- D. Section 22 0100 - General Provisions
- E. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
- F. Section 22 0553 - Identification for Plumbing Piping and Equipment.
- G. Section 22 0719 - Plumbing Piping Insulation.
- H. Section 22 1006 - Plumbing Piping Specialties

1.3 REFERENCE STANDARDS

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.

- A. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- B. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- E. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
- F. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.
- G. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2006.
- H. ASTM B 32 - Standard Specification for Solder Metal; 2004.
- I. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.
- J. ASTM B 306 - Standard Specification for Copper Drainage Tube (DWV); 2002.
- K. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2003a.
- L. ASTM D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.
- M. ASTM D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.
- N. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004.
- O. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2008.
- P. ASTM D 2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2004.
- Q. ASTM D 2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.

- R. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).
- S. ASTM D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2006.
- T. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).
- U. 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.
- V. 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.
- W. IBC - ICC - International Building Code
- X. IPC - ICC - International Plumbing Code
- Y. IFGC - ICC - International Fuel Gas Code
- Z. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.
- AA. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- AB. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2008.
- AC. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- AD. 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.

1.4 SUBMITTALS

- A. In addition to the requirements of Division 01 specifications, plumbing product submittals shall be in accordance with the following:
 - 1. 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 and associated specification section. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.

2. 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.
3. Project Record Documents: Record actual locations of valves. Provide valve schedule as required in Section 22 0553 "Identification for Plumbing Piping and Equipment".
4. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data in Maintenance Manual.
5. Maintenance Materials: Furnish the following for Owners use in maintenance of project.
 - a. See Section 01 6000 - Product Requirements, for additional provisions.
 - b. Valve Repacking Kits: One for each type and size of valve.

B. Review of submittals which do not clearly indicate the information noted below 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. P.C. is responsible to review plumbing product submittals provided by suppliers and coordinate and verify all submittal information prior to submission to Architect/Engineer.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Pennsylvania, UCC standards.
 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.I 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.I, 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 UCC building codes including but not limited to IPC, IFGC, IBC, and IFC (Latest editions).
- B. Conform to International Plumbing Code and all requirements of the local authority having jurisdiction/local Water Authority for installation of backflow prevention devices, service valving, and metering.
- C. Submit product data for backflow prevention devices, service valving, and meters to the Municipal Water Authority prior to submission to Architect/Engineer. Obtain approval for devices and installation details and submit written approval with product data submittal to Architect/Engineer.
- D. 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 Section 01 6000 - Project Requirements, for additional provisions.
- B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. 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.
- B. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 WASTE/SANITARY SEWER & VENT PIPING, BELOW SLAB/GRADE AND BURIED WITHIN 5 FEET OF BUILDING

- A. 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 room/space 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 & VENT PIPING, ABOVE SLAB/GRADE

- A. Cast Iron Pipe: CISPI 301, hubless.
 - 1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe

2. Fittings: Cast iron.
3. Joints: Heavy Duty Couplings: ASTM C 1540/ASTM C 564/FM 1680 Class 1, neoprene gaskets and smooth 304 stainless steel clamp-and-shield assemblies with .010in minimum thickness corrugated shield, four clamps for sizes 1-1/2"-4", six clamps for sizes 5"-10", and worm gear drive clamps torqued to 80 inch pounds.

2.4 DOMESTIC POTABLE AND NON-POTABLE WATER PIPING, ABOVE SLAB

- A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
1. Fittings: Provide fittings from one of the options below. All fittings/components within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%) and other equivalent state regulations
 - a. Soldered Fittings (all pipe sizes): ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - b. Copper Press Fittings (all pipe sizes): Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements. fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Copper press fittings shall be manufactured by Viega and installed utilizing Rigid Tool Company as "Pro Press System" or equal system as approved by Engineer. Complete installation shall comply with manufacturers recommendations.
 2. Joints: Provide pipe joints from one of the options below.
 - a. Solder Joints(All Sizes): ASTM B32, alloy Sn95 solder.
 - b. Press Fit Joints(All Sizes): ProPress (as specified above)
 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.

2.5 STORM 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. PVC Pipe: ASTM D 2665 or ASTM D 3034. (No Foam Core Permitted)
1. Manufacturers:
 - a. Charlotte Pipe and Foundry

- b. Spears
- c. Cresline
- 2. Fittings: PVC (DWV pattern).
- 3. Joints: Solvent welded, with ASTM D 2564 solvent cement.
- 4. Transition: Use appropriate transition joints as required for connection to dissimilar piping materials. Transition from PVC below grade piping to cast iron pipe above grade shall occur 6" -12" above slab.

2.6 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: ASTMC-1540/ASTMC-564/FM 1680 Class 1, neoprene gaskets and smooth 304 stainless steel clamp-and-shield assemblies with .010in minimum thickness corrugated shield, four clamps for sizes 1-1/2"-4", six clamps for sizes 5"-10", and worm gear drive clamps torqued to 80 inch pounds.

2.7 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. PSI Industries.
 - f. Stockham Valves and Fittings.

2.8 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. 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.
- E. Soldering Materials: Except as otherwise indicated, provide lead free soldering materials as determined by the installer to comply with installation requirements.
- F. Tin-Antimony Solder: ASTM B32, Grade 95YA.
- G. Gaskets for Flanged Joints: ANSI B16.21 full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated.
- H. 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.

2.9 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, for insulated piping systems..
 - a. Adjustable Clevis Hangers: MSS-SP-69 Type 1, fabricated from steel. (Insulated or Non-insulated - Stationary piping systems)
 - b. Adjustable Swivel Band Hangers: MSS-SP-69 Type 10 fabricated from steel. (Non-insulated - Stationary piping systems)
 - c. Adjustable Roller Hangers: MSS-SP-69 Type 43, including axle roller and clevis. (Insulated or Non-insulated - Non-Stationary piping systems)
 - d. 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-SP-69 Type 8.
 - b. Four Bolt Riser Clamp: MSS-SP-69 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-SP-69 Type 13.
 - b. Weldless Eye Nut: MSS-SP-69 Type 17.
 - c. Malleable Eye Socket: MSS-SP-69 Type 16.
 - d. Clevises: MSS-SP-69 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-SP-69 Type I8, steel.
 - b. Top Beam C-Clamps: MSS-SP-69 Type I9.
 - c. C-Clamps: MSS-SP-69 Type 23, steel
 - d. Top I-Beam Clamp: MSS-SP-69 Type 25.
 - e. Side Beam Clamp: MSS-SP-69 Type 20.
 - f. Beam Clamp/Eye Nut: MSS-SP-69 Type 28.
 - g. Wide Flange Beam Clamp/Eye Nut: MSS-SP-69 Type 29.
 - h. Beam Clamp/Extension Piece: MSS-SP-69 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-SP-69 Type 39.
 - b. Protection Shields: MSS-SP-69 Type 40.
 - c. Wood Insulation Saddle: Provide products manufactured by Elcen Metal Products Company.

F. RESTRAINTS

1. General: Provide No-Hub Cast Iron Joint restraints as required by local Plumbing Codes, CISPI Designation 310-11, and the 2006 CISPI Installation Handbook. 24 ga. CRS, galvanized straps, stainless steel bands and worm gear drive clamps.
 - a. HoldRite Series #117

G. 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 a 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.

2.10 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.

- B. All valves and specialties within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%), NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372, and other equivalent state regulations.
- C. All shutoff valves 4" and smaller within the domestic potable water piping shall be full port ball valve type unless noted otherwise.
- D. BALL VALVES:
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
 - a. Conbraco Industries, Inc.
 - b. Milwaukee Valve Co., Inc.
 - c. NIBCO, Inc.
 2. General: Valves shall be rated 600 PSI non-shock CWP, valve ends shall have full depth ANSI threads or extended solder connections.
 3. Comply with the following standards: MSS SP-110
 4. Domestic Water Service: Valves shall be rated 600 PSI non-shock CWP and will have 2-pc. lead-free * dezincification-resistant bronze body, end piece, stainless steel stem and ball, PTFE seats, full port, separate pack nut with adjustable stem packing, anti-blowout stems and have the capability of accepting extended operating handles. Valve ends shall have full depth ANSI threads or extended solder connections. Valves shall be 3rd party certified to NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372. 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.
 - a. Basis of Design(threaded ends): NIBCO T585HP-66-LF (1/2" to 3")
 - b. Basis of Design(Soldered): NIBCO S585HP-66-LF (1/2" to 3")
 - c. Basis of Design(PressFit): NIBCO PC-585HP-66-LF (1/2" to 3")
 5. Natural Gas Service (Line Service Valve - up to 5psi. 1/2"-2"): Threaded Ends 2" and Smaller: 600#WOG, ASME B16.33, ASME B16.44-2G(2psig service), ASME B16.44-5G(5psig service), Full port, forged brass/bronze 2 piece body, hard chrome plated forged brass/bronze ball, blow-out proof stem.
 - a. Basis of Design: NIBCO® T-FP-600A-LF (threaded)
 6. Natural Gas Service(Appliance Shutoff - up to 5psi, 1/2"-1"): Threaded Ends 1" and Smaller: 600# W.O.G., Full port, ANS Z21.15/CSA 9.1 listed for 1/2psig indoor appliance connections, lever handle, forged brass/bronze body, hard chrome plated forged brass/bronze ball, blow-out proof stem.
 - a. Basis of Design : NIBCO GB Series
- E. MANUAL BALANCING VALVES
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
 - a. Conbraco Industries, Inc.
 - b. Milwaukee Valve Co., Inc.

- c. NIBCO, Inc.
 2. Domestic Hot Water Service: Return branch balancing valves ½ " to 2" shall be Globe Style, . Valve shall have integral metering/test ports for flow balancing and flow measurement. Test ports shall have internal check valve and be equipped with caps. Valves shall be manufactured from lead free dezincification resistant brass or bronze rated 240 psi at 250 F. All balancing valves shall have position indication readout and built in memory stop for repeatable regulation and control.
 - a. Basis of Design: NIBCO ® Series 1810-LF
- F. CIRCUIT SETTER BALANCING VALVES
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
 - a. Bell & Gosset
 2. Domestic Hot Water Service: Circuit Balancing Valves ½ " to 2" shall be Lead Free ball valve style. Valve shall have integral metering/test ports for flow balancing and flow measurement and be able to be pre-set to appropriate flow. Test ports shall have internal check valve and be equipped with caps. Valves shall be manufactured from dezincification resistant brass or bronze rated 240 psi at 250 F. All circuit balancing valves shall have calibrated nameplates with position indication readout and built in memory stop for repeatable regulation and control and designed for positive shutoff.
 - a. Basis of Design: Bell & Gosset ® CB - LF Series
- G. SWING CHECK VALVES:
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
 - a. Conbraco Industries, Inc.
 - b. Milwaukee Valve Co., Inc.
 - c. NIBCO, Inc.
 2. Comply with MSS SP-71 and MSS SP-SO for design, workmanship, material and testing.
 3. For Domestic Water Service: Valves shall be Y-pattern swing-type rated 200 PSI non-shock CWP. Body, bonnet, and disc hanger are to be of lead-free dezincification-resistant material and PTFE seat disc. Valve ends may be threaded or solder-type. Valves shall be 3rd party certified to NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372.
 - a. Basis of Design: NIBCO ® T413-Y-LF (threaded); S413-Y-LF (solder)
- 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 P16.24 (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 bronze materials, of standard alloy recognized in the valve manufacturing industry that resists dezincification and meets the Lead free requirements
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 bridgwall of valve body and manufactured for automatic closure by flow reversal.

2.11 LOW PRESSURE Y-TYPE STRAINERS:

- A. Manufacturer: Subject to compliance with requirements, provide low pressure Y-Type strainers of one of the following:
 1. Armstrong Machine Works.
 2. Hoffman Specialty, ITT Fluid Handling Div.
 3. Metraflex Co.
 4. Crane Co., Valve Div.
 5. Milwaukee Valve Co., Inc.
 6. NIBCO, Inc-
- B. 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.
- C. All valves and specialties within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%) and other equivalent state regulations
 1. Threaded Ends: 2" and Smaller: Lead Free Bronze body rated for 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with threaded ball valve and 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 threaded ball valve and pipe plug.
 3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with threaded ball valve and pipe plug.

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 to each system.
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 including elevator machine rooms.
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. Ream 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. Solder copper tube and fittings joints in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
8. Weld pipe joints in accordance with ANSI B31.

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, Condensate Drainage, and Radon Remediation piping shall be installed at a minimum continuous 1% slope (1/8" per foot).
14. Provide penetration firestopping for all work of Div. 22 in accordance with Div. 07 specifications.

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 IPC or as required otherwise by local AHJ. Perform bacteriological and chemical contaminant testing in accordance with IPC and submit test results to Engineer and local AHJ.

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 piping installations and backflow preventers in accordance with IPC Section 312. Coordinate testing with local AHJ.
4. 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.

D. PIPING DISINFECTION

1. Disinfect potable water supply piping in accordance with IPC Section 610 or as required otherwise by local AHJ. Perform bacteriological and chemical contaminant testing in accordance with IPC and submit test results to Engineer and local AHJ.

E. 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.

F. 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 and IPC. 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.

G. 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 or 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.

H. PIPE GUIDE INSTALLATION:

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

I. 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.

J. ADJUSTMENT OF HANGERS AND SUPPORTS:

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

K. 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.

L. 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.

- M. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- N. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- O. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- P. Group piping whenever practical at common elevations.
- Q. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.
- R. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- S. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.
- T. Establish elevations of buried piping outside the building to ensure not less than four ft of cover.

- U. Install vent piping penetrating roofed areas to maintain integrity of roof assembly. Coordinate all requirements with roof installer. Install vent piping penetrations in existing roof assemblies in accordance with all requirements of the roof manufacturer to maintain existing roof warranty.
- V. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- W. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 9000.
- X. Install bell and spigot pipe with bell end upstream.
- Y. Install valves with stems upright or horizontal, not inverted.
- Z. Install water piping to ASME B31.9 and IPC requirements.
- AA. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
- AB. Sleeve pipes passing through partitions, walls and floors.

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. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Provide spring loaded check valves on discharge of water pumps.
- E. Provide flow controls in water recirculating systems where indicated. Balance recirculation system to achieve timely delivery of hot water to all plumbing fixtures in accordance with IECC and local Health Department requirements.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with IPC, AWWA, or other method as directed by Local A.H.J. Where sanitizing procedure is not specified by local codes follow the procedure below.
 1. Prior to starting work, verify system is complete, flushed and clean.
 2. 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).
 3. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
 4. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
 5. Maintain disinfectant in system for 24 hours.

6. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
7. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
8. 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.

END OF SECTION 221005

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 221006 - PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleanouts.
- B. Floor drains.
- C. Hose bibbs.
- D. Hydrants.
- E. Pressure reducing valves
- F. Shock Absorbers/Water hammer arrestors.
- G. Thermostatic mixing valves.

1.2 RELATED REQUIREMENTS

- A. Section 22 0100 - General Provisions
- B. Section 22 1005 - Plumbing Piping.
- C. Section 22 3000 - Plumbing Equipment.
- D. Section 22 4000 - Plumbing Fixtures.

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; 2009 (ANSI/ASSE 1012).
- E. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011
- F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011

- G. IBC - ICC - International Building Code
- H. IPC - ICC - International Plumbing Code
- I. IFGC - ICC - International Fuel Gas Code
- J. NSF 61 - Drinking Water System Components - Health Effects; 2014 (Errata 2015)
- K. NSF 372 - Drinking Water System Components - Lead Content; 2011
- L. PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute; 2006.

1.4 SUBMITTALS

- A. See Section 01 3000 - 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.

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 Section 01 6000 - Product Requirements, for additional provisions.
- B. Supply the following for Owner's use in maintenance of project:
 - 1. Two loose keys for outside hose bibbs.
 - 2. Two hose end vacuum breakers for hose bibbs.
 - 3. One service kit for each type/style and size of backflow preventer.
 - 4. One service kit for each type/style and size of pressure reducing valve.
 - 5. Two service kits for each type/style and size of hydrant/washdown box, etc.
 - 6. One replacement valve for every 10 of each type/style and size of point of use Thermostatic mixing valve
 - 7. One service kit for each type/style and size of Master Mixing Thermostatic mixing valve
 - 8. One replacement water hammer arrestor for every 10 of each type/style and size of water hammer arrestor
 - 9. One service kit for each backwater valve.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Specialties installed within Potable Water Supply Systems: Provide "Lead Free" products that comply with NSF 61 and NSF 372 for maximum lead content.

2.2 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. Wilkin/Zurn Industries, Inc: www.zurn.com.
 - 5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.
- B. Double Check Backflow Preventers (1/4"-2"):
 - 1. ASSE 1015; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; assembled with two quarter turn ball valves, strainer, and four test cocks.
 - a. Watts Model S-QT-LF007 or approved equal
- C. Beverage Dispenser Connection Backflow Preventers (1/4"-3/8"):
 - 1. ASSE 1022; NSF; Dual Check w/atmospheric vent, 316SS body and adapters; two independently operating check valves w/atmospheric vent, strainer.
 - a. Watts Model SD-3 w/strainer or approved equal
 - 2. Pipe atmospheric vent to visible air gap discharge

3. All downstream piping to beverage dispenser shall be 316SS (no copper permitted)

2.3 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. Wade: www.wadedrains.com.
6. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

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

1. Lacquered cast iron body with flashing flange, threaded ABS plug assembly, and round Nickel Bronze cover. Cover shall be scoriated in service areas, round recessed cover to accept floor finish in terrazzo and similar floor areas, and carpet marker type for units installed in carpeted areas (refer to Architectural floor finish plans for additional information).
2. Basis of design: J.R. Smith Model 4020/4031/4025 series with cover style/finish as required by final floor finish (Outlet connection type as determined by P.C)
3. Basis of design J.R. Smith Model 4100 series (Heavy Duty Traffic Areas)(Outlet connection type as determined by P.C)

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

2.4 FLOOR DRAINS

A. Manufacturers:

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

B. (FD-1) Floor Drain - General area floor drains, toilet rooms, showers, etc.:

1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, twist-to-floor adjustable nickel bronze strainer.
 - a. Deep seal P-trap
 - b. Pro-Set "trap-guard" sewer gas prevention system.
 - c. Sediment bucket option in all shower floor drain
2. Refer to drawings for locations and system sizes.

3. Basis of Design:
 - a. J.R. Smith: Model 2005-NB with 6" round strainer, drain outlet size shall be as indicated on drawings.

2.5 HOSE BIBBS

- A. Manufacturers:
 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 2. Josam Company: www.josam.com.
 3. Woodford
 4. Watts Regulator Company: www.wattsregulator.com.
 5. Zurn Industries, Inc: www.zurn.com.
 6. Mifab Drainage Products
 7. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.
- B. (HB-1) Interior Hose Bibbs:
 1. Chrome Plated Bronze or brass with integral wall flange, replaceable hexagonal disc, hose thread spout, interchangeable handwheel and loose key operation, integral vacuum breaker in conformance with ASSE 1011.
 2. Basis of Design: Woodford Model 40HT

2.6 NON FREEZE WALL HYDRANT

- A. Manufacturers:
 1. Josam Company: www.josam.com.
 2. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 3. Zurn Industries, Inc: www.zurn.com.
 4. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.
- B. (NFWH-1) Enclosed Non-Freeze Wall Hydrants:
 1. ASSE 1019-B, ASSE 1052, ASSE 1053; freeze resistant, box type, self-draining type with polished bronze wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker.
 2. Installation Height: Approx.. 24" above grade (totally within same color masonry) Coordinate exact locations and elevations with architect prior to rough-in.
 - a. Basis of Design: Jay R. Smith Manufacturing Company; Model 5519-WC-CL-NB (verify wall thickness in field)

2.7 NON FREEZE ROOF HYDRANT

- A. Manufacturers:
 1. Woodford: www.woodfordmfg.com

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

B. (NFRH-1) Enclosed Non-Freeze Wall Hydrants:

1. ASSE 1057, 1052; freeze resistant, self-draining with 1/8" drain piped to indirect drain receptor, dual check backflow preventer w/hose thread spout, and integral vacuum breaker/air vent, deck mounted hydrant support with underdeck clamp, 2deg. shim for pitch adjustment.
 - a. Basis of Design: Woodford Model RHY2-MS (Contractor shall pipe drain to nearest janitor room mop receptor or approved indirect waste location. Verify in field)

2.8 SHOCK ABSORBERS/WATER HAMMER ARRESTORS

A. Manufacturers:

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

B. Water Hammer Arrestors:

1. Stainless steel construction, Bellows type or Piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.

2.9 THERMOSTATIC MIXING VALVES

A. Manufacturers:

1. Acorn Engineering: T/P with Paraffin actuator.
2. Powers Valves: T/P with Paraffin actuator.
3. Zurn Industries/Wilkins: (Approved For Lavatory Tempering valves)
4. Watts: (Approved For Lavatory Tempering valves)
5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

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. Maximum temperature setting 110°F.
 - a. Powers Series LFE480 must be rated for minimum flow of 0.5 gpm.
 - b. Zurn; Aquaguard Model ZW3870XLT (single temp faucet), ZW3870XLT-4P (dual temp faucet)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all plumbing specialties in accordance with manufacturer's instructions.
- B. Cleanouts
 - 1. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
 - 2. Encase exterior cleanouts in concrete flush with grade.
 - 3. Install floor cleanouts and floor drains at elevation to accommodate finished floor with strainer or cover flush with finish floor.
- C. Floor drains
 - 1. Install floor drains at elevation to accommodate finished floor with strainer or cover flush with finish floor unless specifically noted otherwise.
 - 2. Provide Mechanical trap seal protection similar to ProSet Trapguards at all floor drain locations. Where required by Authority Having Jurisdiction, provide trap primers, trap primer connection on drain, and all associated piping to connect trap primer to drain.
- D. Backflow preventers
 - 1. Install approved potable 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.
 - 2. Install all backflow preventers in easily accessible location to permit annual testing and maintenance max. 48" above finish floor.
 - 3. Provide pressure gauges on inlet and outlet piping of all backflow preventers.
 - 4. Pipe relief from all RPZ backflow preventers air gap drain fittings to nearest floor drain or approved discharge location.
- E. Shock Absorbers / Water Hammer Arrestors
 - 1. Install water hammer arrestors complete with accessible isolation valve on water supply piping serving all washing machine outlets, urinals and water closet flush valves.
- F. Non-Freeze Wall Hydrants
 - 1. Install Approx. 24" above grade (totally within same color masonry) Coordinate exact locations and elevations with architect prior to rough-in.
- G. Non-Freeze Roof Hydrants
 - 1. Install minimum 30" above roof. Coordinate installation with roofing installer. For existing roof installations, install hydrant in accordance with all roofing manufacturers requirements to maintain roofing warranty.

2. Properly support and brace hydrant in accordance with all manufacturers recommendations. Where manufacturer does not include braicing recommendations, Contractor shall

H. Thermostatic Mixing Valves

1. Install all mixing valves in strict accordance with all manufacturers recommendations and piping installation requirements.
2. Install mixing valves at the proper ASSE rating and capacities where indicated on the drawings and details. Provide mixing valves as specified above at all lavatory and handwash sink locations.

END OF SECTION 221006

SECTION 223000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Domestic Hot Water Circulators.
- B. Instantaneous Point-of-Use 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.

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 Div. 01 specifications, for additional provisions.

- B. Provide all required maintenance parts for up to 1 yr. for all required regular maintenance

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 manufacturers representative where necessary or where otherwise noted in these specifications.

PART 2 PRODUCTS

2.1 DOMESTIC HOT WATER CIRCULATOR PUMPS - IN LINE

- A. Manufacturers:
 - 1. Armstrong
 - 2. Grundfos
 - 3. Thrush
 - 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.
- B. Casing: Lead Free Bronze or Stainless Steel rated for 125 psig working pressure, with stainless steel rotor assembly.
- C. Impeller: 30% glass-filled Noryl or Bronze.
- D. Shaft: Stainless steel w/permanently lubricated stainless steel bearings
- E. Seal: Silicon-Carbide rotating against a stationary ceramic seat.
- F. Gaskets: EPDM
- G. Controls: Programmable timer and Aquastat(provide programmable timer only as required by local AHJ)
- H. Performance:
 - 1. Refer to Plumbing Detail drawings for pump sizes and requirements

2.2 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 individual models and specifications.
- C. Construction: Manufacturer's standard and without hot-water storage.
- D. Working-Pressure Rating: 150 psig (1035 kPa).
- E. Electric Heating System: Ni chrome electric-resistance type.
- F. Cover: UL rated 94 Vo.
- G. Mounting: Bracket or device for wall mounting.
- H. Temperature Control: Microprocessor controlled, Factory pre-set, temperature-control thermostat for adjustable, outlet-water temperature (110F maximum setting for Public Lavatories and Conforming to ASSE1070 TR).
- I. Safety Control: Automatic, high-temperature-limit cutoff.
- J. Schedule
 - 1. Refer to drawings

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/fuel piping for each piece of equipment to achieve operating system
- C. Provide Concrete housekeeping base of sufficient size for all floor mounted equipment. Concrete bases shall be dowelled into floor decking. Coordinate all work with G.C. in field.
- D. Domestic Hot Water Recirculation Pumps
 - 1. Refer to Plumbing details for pump installation information and associated piping accessories.
 - 2. Provide main circuit setter valve set to specified flow for each hot water recirculation system. Balance hot water recirculation system at all balancing valve and circuit setter valve locations to achieve timely delivery of hot water to all fixtures in accordance with IECC and local Health Department requirements.
 - 3. Install circulation pumps in orientation as required by manufacturers recommendations.
 - 4. Coordinate power wiring to pump and aquastat controls with E.C. in field.

- E. Pumps:
 - 1. 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.
 - 2. Provide vibration isolation/flexible connectors on inlet and outlet piping

- F. Instantaneous Point-of Use Water Heaters
 - 1. Verify and coordinate electrical requirements including voltage and amperage of unit to be provided with E.C. in field prior to order/installation.
 - 2. Perform the following final checks before startup:
 - a. Verify accessible disconnecting means has been provided and until is wired with GFI protection.
 - b. Fill water heaters with water.
 - c. Check that piping system tests are complete.
 - d. Check for piping connection leaks.
 - e. Test operation of safety controls, relief valves, and devices.
 - 3. Perform the following startup procedures:
 - a. Energize electric circuits.
 - b. Adjust operating controls where required.
 - c. Verify hot water outlet temperature is within max and min. temperature limits for each fixture type.
 - 1) Handwash/Lavatory - 90F min./110F max.
 - 2) Sink - 110F min./120F max.
 - d. Adjust hot-water-outlet temperature settings as necessary

END OF SECTION 223000

SECTION 223300 - ELECTRIC WATER HEATERS

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 electric water heaters and accessories.

1.3 REFERENCE STANDARDS

- A. ICC (IPC) - International Plumbing Code
- B. ASHRAE/IES ; 90.1b-2019 - ASHRAE Standard Energy Efficient Design of New Buildings Except Low-rise Residential Buildings
- C. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.
- D. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. 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.
- B. 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.
- C. Product certificates signed by manufacturers of water heaters certifying that their products comply with specified requirements.
- D. Maintenance data for water heaters to include in operation and maintenance manuals. Include startup instructions.

1.5 QUALITY ASSURANCE

- A. NFPA Standard: Comply with NFPA 70, "National Electrical Code," for electrical components.
- B. Listing and Labeling: Provide electrically operated water heaters, controls, and components specified in this Section that are listed and labeled.
- 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. Other manufacturers' water heaters and accessories with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

1.6 WARRANTY

- A. General Warranty: The special warranty specified shall not deprive Owner of other rights Owner may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.
 - 1. Special Warranty: Submit a written warranty executed by manufacturer agreeing to repair or replace water heaters and accessories that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, tanks and elements. This warranty is in addition to, and not a limitation of, other rights Owner may have against Contractor under Contract Documents.
- B. Warranty Period: 5 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATERS, GENERAL

- 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, 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.
- I. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. 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.

2.2 COMMERCIAL LIGHT DUTY, ENERGY SAVER, STORAGE, ELECTRIC WATER HEATERS

- 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.O.Smith
 - b. Bradford White Corp.
 - c. Rheem Mfg. Co.
 - d. State Industries
- B. Description: UL 174, but listed by manufacturer for commercial applications, or UL 1453, light-commercial, storage, electric water heater; with capacity of no less than 6 gal. (151 L), but not more than 120 gal. (454 L), and input not more than 12 kW. ASHRAE 90.1b compliant
- C. Storage Tank Construction: Heavy gauge steel automatically rolled formed and welded; NSF-61 Glass/enamel lined, ASME B1.20.1 pipe thread tappings, 150-psig working-pressure rating. Non ASME rated.
 - 1. Thermally insulated with minimum 2 inches glass fiber, comply with ASHRAE/IESNA 90.1, encased in corrosion-resistant steel jacket with baked-on enamel finish.
- D. Heating Elements: (1) or (2) screw-in, immersion type incoloy element(s) wired for Non simultaneous or simultaneous operation (as noted on drawings).

- E. Controls: Adjustable fast acting surface mount thermostats, high temperature limit energy cutoff system
- F. Corrosion protection: Factory installed Magnesium anode rod(s)
- G. Factory Installed Appurtenances:
 - 1. 3/4 in. or 1 in. Dielectric water connections, heat traps, and dip tube with integral vacuum breaker
 - 2. Drain Valve: Low restriction brass ball-type complying with ASSE 1005.
 - 3. Insulation: Comply with ASHRAE/IESNA 90.1[or ASHRAE 90.2].
 - 4. Jacket: Steel with painted finish.
 - 5. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting at 150 psig (1035 kPa). Select relief valve with sensing element that extends into storage tank.
- H. Vacuum Relief Valve: Comply with ASME PTC 25.3. Furnish for installation in piping.
 - 1. Exception: Omit where water heater has integral vacuum relieving device.
- I. Special Requirements: NSF 5 construction with legs for off-floor installation.
- J. Warranty: 5 year tank warranty/1 year component part warranty
- K. Water Heater Schedule
 - 1. Refer to Drawings for Model info.

PART 3 - EXECUTION

3.1 CONCRETE BASES

- A. Provide concrete bases of required dimensions indicated for floor mounted water heaters and accessories. Refer to Section 033000 "Cast-in-Place Concrete" and applicable Division 22 Plumbing Sections."
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.

3.2 WATER HEATER INSTALLATION

- A. General: Install water heaters as indicated on drawings. 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.
- B. Provide drain pan of adequate size for water heater with outlet piped to floor drain.
- C. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 221005 Plumbing Piping.

- D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination 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.
- F. Install water heater drain piping (where indicated on drawings and details) 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.
- G. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Division 22.0519 - Meters and Gages for Plumbing Piping.
- H. Install pressure gages on water heater piping when and as indicated. Pressure gages are specified in Division 22.0519 - Meters and Gages for Plumbing Piping.
- I. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Install piping adjacent to water heaters to allow service and maintenance. In parallel water heater installations, install water piping to allow removal of one unit with second unit in service.

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. Connect hot-water circulating piping to unit with shutoff valve, check valve, and union.
 - 2. Make connections with dielectric fittings where piping is made of dissimilar metals.
- 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. Perform the following final checks before startup:
 - 1. Fill water heaters with water.
 - 2. Check that piping system tests are complete.

3. Check for piping connection leaks.
 4. Check and install appropriate aerators/flow Restrictors on fixtures at point of use heater applications
 5. Test operation of safety controls, relief valves, and devices.
- B. Perform the following startup procedures:
1. Energize electric circuits.
 2. Adjust operating controls.
 3. Adjust hot-water-outlet temperature settings.
 4. Adjust thermostatic mixing valve and balance hot water return system

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. (EWC) Electric Water Coolers
- B. (LAV) Lavatories.
- C. (MR) Mop Receptors
- D. (SINK) Sinks.
- E. (WC) Water closets.

1.2 RELATED REQUIREMENTS

- A. Division 01 Specifications
- B. Section 07 9005 - Joint Sealers: Seal fixtures to walls and floors.
- C. Section 22 1005 - Plumbing Piping.
- D. Section 22 1006 - Plumbing Piping Specialties.
- E. Section 22 3000 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

- A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2004.
- B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2006.
- C. ARI 1010 - Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; Air-Conditioning and Refrigeration Institute; 2002.
- D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).
- E. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.
- F. ASME A112.19.2 - Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals; The American Society of Mechanical Engineers; 2008.

- G. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; The American Society of Mechanical Engineers; 2008.
- H. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 2005.
- I. IBC - ICC - International Building Code
- J. IPC - ICC - International Plumbing Code

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Samples: Submit two lavatory supply fittings.
- D. Manufacturer's Instructions: Indicate installation methods and procedures.
- E. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners's name and registered with manufacturer.
- G. Maintenance Materials: Furnish the following for Owners use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Supply two sets of faucet washers.

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.

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. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for electric water cooler.
- C. EXTRA MATERIALS
 - 1. See Section 01 6000 - Project Requirements, for additional provisions.
 - 2. Supply two sets of faucet washers, flush valve service kits, lavatory supply fittings, and toilet seats.
 - 3. Supply two

PART 2 PRODUCTS

2.1 (EWC-#) ELECTRIC WATER COOLERS - REFER TO DRAWINGS FOR LOCATIONS.

- A. Electric Water Cooler Manufacturers:
 - 1. Elkay Manufacturing Company: www.elkay.com.
 - 2. Haws Corporation: www.hawesco.com.
 - 3. Oasis: oasiswatercoolers.com
 - 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
- B. (EWC-1) SURFACE MOUNTED, BI-LEVEL - BARRIER FREE, FILTERED, ELECTRIC WATER COOLER w/BOTTLE FILLER (VANDAL RESISTANT) - Refer to Drawings for locations.
 - 1. Water Cooler: Electric, mechanically refrigerated. Bi-level surface mounted with; stainless steel top, stainless steel body panels with #4 finish, elevated anti-squirt Chrome vandal resistant bubbler with flexible stream guard, automatic stream regulator, vandal resistant front push button activation, integral air cooled chiller, water filter.
 - 2. Bottle Filler: touchless sensor activation, visual filter monitor, green ticker bottle counter
 - 3. Chiller Capacity: 8 gallons per minute 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, 260 watts, 3.8 FLA, manufacturer provided cord and plug electrical connection
 - 5. Compliance Standards:
 - a. ADA/ANSI A117.1
 - b. NSF/ANSI 61 & 372
 - c. NSF 42 & 53 (Filter)
 - d. GreenSpec Listed
 - 6. Accessories
 - a. In wall carrier
 - b. Cane apron

7. Basis of Design:
 - a. Elkey: LVRGGRNTL8WSK- LKAPREZL - MLP200

2.2 (LAV-#) LAVATORIES

- A. Manufacturers:
 1. Basin: (Vitreous China)
 - a. American Standard Inc: www.americanstandard.com.
 - b. Kohler Company: www.kohler.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. Electronic Sensor Faucets:
 - a. Sloan Valve Company: www.sloanvalve.com.
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
 3. Manual Faucets:
 - a. Chicago: www.chicagofaucets.com.
 - b. Moen Commercial: www.moen.com.
 - c. T&S Brass: www.tsbrass.com
 - d. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. 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 prior to Bid. Refer to Division 01 specifications for additional information.
- B. (LAV-1/LAV-2/LAV-3) LAVATORY, VITREOUS CHINA UNDERMOUNT (Toilet Rooms)
- Refer to Drawings for locations.
 1. Vitreous China, Rectangular, Undermount basin: ASME A112.19.2; vitreous china, 20 in. x 16 in.
 - a. Color: White
 - b. Basis of Design: Kohler Caxton K-20000
 2. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with concealed sensor located on neck of spout.
 - a. Spout Style: Standard.
 - b. Power Supply: 24 VAC hardwired
 - 1) Plug in AC adapter

- 2) For 24V applications, provide transformer and low voltage wiring in accordance with all manufacturers requirements
- c. Water Supply: 3/8 inch compression connections.
- d. Aerator: Vandal resistant, 0.5 GPM, laminar flow device.
- e. Finish: Polished chrome.
- f. Basis of Design: Kohler K-103C36-SANA with K-13480 AC adapter
3. Accessories:
 - a. Mixing Valve: Below deck thermostatic tempering valve conforming to ASSE 1070 standard.
 - b. Chrome plated 17 gage or semi-cast brass P-trap with clean-out plug and arm with escutcheon.
 - c. Chrome plated perforated grid strainer.
 - d. Commercial grade, loose key operated, 1/4 turn, chrome plated angle stops with threaded connections and chrome plated escutcheon.
 - e. Flexible chrome plated copper supplies.
 - f. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84. Truebro LavGuard or equal.

2.3 (MR-#) MOP RECEPTORS - REFER TO DRAWINGS FOR LOCATIONS.

A. Service Sink Manufacturers:

1. Acorn:
2. Fiat
3. Stern-Williams:
4. Florestone:
5. Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (MR-1) MOP RECEPTOR - NEO-CORNER, FLOOR MOUNTED, TERRAZZO

1. Basin:
 - a. 24 x 24 inch x 12 inch high, terrazzo, floor mounted, neo corner style with drop front, 1 inch wide shoulders, stainless steel shoulder guard, and tiling flange.
 - b. Acorn: Model TNC-24
2. Faucet: Chrome plated cast Brass, integral vacuum breaker, pail hook, wall support
 - a. Basis of design: Chicago Faucets: 897CCP
 - b. Install check valves on hot and cold water supplies to faucet.
3. Accessories:
 - a. KH36 hose and clamp hanger bracket, 3 feet of 5/8 inch diameter plain end reinforced rubber hose.
 - b. KMH Mop hanger.
 - c. KWG2-24 Stainless steel wall guards

- d. KF24 tiling flange
- e. KDG3 Drain Gasket
- 4. Refer to Mop Receptor Detail for additional accessories and installation. Provide HB-1 hose bibb with 3/4"C connection and provide EEW-1 Eyewash/Drench hose assembly. Refer to section 22 1006 Plumbing Piping Specialties" for additional information.

2.4 (SINK-#) SINKS - REFER TO DRAWINGS FOR LOCATIONS.

- A. CONTRACTOR SHALL COORDINATE SPECIFIED SINK TYPE, SIZE, AND DIMENSIONAL REQUIREMENTS **WITH CASEWORK SUPPLIER IN FIELD PRIORTO RELEASE OF ORDER**. Contractor is responsible for final verification of size and type.
- B. Manufacturers:
 - 1. Sink:
 - a. Elkay Corporation: www.elkayusa.com.
 - b. Just Manufacturing Co.: www.just.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. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
- C. (SINK-1) - Single Compartment Bowl - ADA - Kitchennette, etc.
 - 1. Undermount Sink: ASME A112.19.3, ANSI A117.1/ADA; 18 gage thick, Type 304 stainless steel, undercoated.
 - a. Bowl Size: 16 in.(front to back) by 19 in. (side to side) by 5 in. deep
 - b. Drain: 3-1/2 inch all metal crumb cup with strainer and 17 ga.tailpiece.(ADA units shall be provided with drain outlet centered-rear in bowl
 - c. Basis of Design:
 - 1) Elkay; Model ELUHAD191650
 - 2. Faucet: ASME A112.18.1; chrome plated metal construction, high arc swivel spout with pulldown spray, lever style handle w/ ceramic cartridge, 1.5 gpm.
 - a. Basis of Design:
 - 1) Chicago 434-ABCP
 - 2) Moen Commercial; Model Arbor 7594 (w/trim plate for 3 hole faucet punch)
 - 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.

4. Below deck thermostatic mixing valve, ASSE-1070 compliant. Provide on Hot supply to faucet. Zurn Aquaguard ZW3870XLT
5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84

D. (SINK-2/SINK-3) - Single Compartment Bowl - ADA - Conference, Mothers, etc.

1. Undermount Sink: ASME A112.19.3, ANSI A117.1/ADA; 18 gage thick, Type 304 stainless steel, undercoated.
 - a. Bowl Size: 16 in.(front to back) by 16 in. (side to side) by 5 in. deep
 - b. Drain: 3-1/2 inch all metal crumb cup with strainer and 17 ga.tailpiece.(ADA units shall be provided with drain outlet centered-rear in bowl
 - c. Basis of Design:
 - 1) Elkay; Model ELUHAD191650
2. Faucet: ASME A112.18.1; chrome plated metal construction, high arc swivel spout with pulldown spray, lever style handle w/ ceramic cartridge, 1.5 gpm.
 - a. Basis of Design:
 - 1) Chicago 434-ABCP
 - 2) Moen Commercial; Model Arbor 7594 (w/trim plate for 3 hole faucet punch)
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.
4. Below deck thermostatic mixing valve, ASSE-1070 compliant. Provide on Hot supply to faucet. Zurn Aquaguard ZW3870XLT
5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84

2.5 (WC-#) WATER CLOSETS

A. Manufacturers(All Water Closets)

1. Bowl:
 - a. American Standard Inc: www.americanstandard.com.
 - b. Kohler Company: www.kohler.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. Flush Valves:
 - a. Sloan Valve Company: www.sloanvalve.com.
 - b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
3. Seats:
 - a. American Standard: www.americanstandard.us.com
 - b. Kohler Company: www.kohler.com.

- c. Bemis Manufacturing Company: www.bemismfg.com.
 - d. Olsonite: www.olsonite.com.
 - e. Kohler Company: www.kohler.com.
 - f. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. 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 prior to Bid. Refer to Division 01 specifications for additional information.
- B. (WC-1,WC-2,WC-3) WATER CLOSET, WALL HUNG (Toilet Rooms) Refer to Drawings for locations.
- 1. Bowl: Vitreous china w/stain resistant antimicrobial finish, White, ASME A112.19.2, ANSI A117.1/ADA compliant, 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: 1.1 - 1.6 gallon per flush
 - b. Supply Connection: 1-1/2 inch Top Spud
 - c. Outlet Size: 4 in.
 - d. Basis of Design:
 - 1) American Standard Inc; Model Afwall Millenium FloWise 3351.101 (wall hung, elongated, top spud)
 - 2) Kohler; Model Kingston Ultra K-84325-0 (wall hung, elongated, top spud)
 - 2. Flush Valve (Hardwired): 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. Exposed Type: All Chrome plated, sweat solder adapter with cover tube and cast wall flange, 1" screwdriver angle stop w/vandal resistant stop cap.
 - c. Power Supply: 24 VAC.
 - 1) Direct wired to junction box.
 - 2) For 24V applications, provide transformer and all low voltage wiring from transformer to faucets/flush valves. Power wirng to transformer shall be provided by the E.C.
 - d. Flush Volume: 1.28gpf
 - e. Basis of design:

- 1) Sloan Valve Company; Model Royal 111 ESS-1.28-TMO, EL-154 transformer and all necessary low voltage cables for complete installation
3. Seats:
 - a. Solid white plastic, elongated, open front, extended back, stainless steel self-sustaining hinge, stainless steel or brass bolts, without cover and anti-microbial finish.
4. Water Closet Carriers:
 - a. ASME A112.6.1M; adjustable compact cast iron frame, minimum 500 lbs static load rating, 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.

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.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 9005, color to match fixture.
- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

- G. Provide all transformers and low voltage wiring required for connection of plumbing fixtures. Install transformers and low voltage wiring in accordance with all manufacturers' requirements and recommendations. Line voltage power supply to the transformer shall be provided by the E.C.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

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

3.6 CLEANING

- A. Clean plumbing fixtures and equipment.

3.7 SCHEDULES

- A. Fixture Heights: Install fixtures to heights above finished floor as scheduled below, where not indicated otherwise on Architectural Interior Elevations and Drawings.
 1. Water Closet:
 - a. Accessible: 18 inches (17 inches min. - 19 inches max.) to top of seat.
 - b. Accessible (Childrens Use - age 12 and younger): 15 inches (11 inches - 17 inches)
 2. Water Closet Flush Valves:
 - a. Standard: 11 inches min. above bowl rim. (coordinate installation at Accessible locations with manufacturers recommendations.)
 - b. Accessible: 11 inches min. above bowl rim. max 44 inches above floor (field coordinate installation at Accessible locations with manufacturers recommendations and grab bar installation.)
 3. Lavatory:
 - a. Standard: 31 inches - 34 inches to top of basin rim.
 - b. Accessible: 34 inches(max.) to top of basin rim.
 4. Electric Water Cooler/Drinking Fountain:
 - a. Standard Adult: 40 inches (38 inches - 43 inches) to spout.
 - b. Accessible: wheelchair (lower bowl) - 36 inches max. to top of spout.
 - c. Accessible: standing persons (upper bowl) - (38 inches min.- 43 inches max.) to spout
 5. Emergency Eye and Face Wash:
 - a. Standard: 36 inches to receptor rim
 - b. Accessible: 36 inches max. to spray heads

6. Emergency Shower:
 - a. Standard: 84 inches to bottom of head.

- B. Fixture Rough-In (Minimum rough in connection sizes indicated. Refer to plans for branch piping and DWV system connections)
 1. Drinking Fountain/EWC:
 - a. Cold Water: 1/2 Inch.
 - b. Waste: 1-1/4 Inch.
 2. Lavatory:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 3. Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 inch.
 4. Mop Basin:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 3 Inch.
 5. Water Closet (Flush Valve Type):
 - a. Cold Water: 1 Inch.
 - b. Waste: 4 Inch.

END OF SECTION 224000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230501 - HVAC GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 FIRE UNDERWRITER SEAL

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

1.2 CONCRETE AND MASONRY WORK

- A. The Contractor shall furnish and install all concrete bases, reinforcing etc. required to install the Mechanical work unless specifically noted otherwise.
- 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.

1.3 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 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.

1.4 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. 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.

1.5 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 short branch connections to fixtures and/or equipment passing through wall or floors shall be equipped with pressed brass, chrome plated, solid-type escutcheons.
- C. Provide angle collars at ducts where they pass through finished walls, floors and ceilings.

1.6 ACCESS DOORS AND PANELS

- A. All ceiling and wall access panels required shall be furnished by this Contractor and set by this Contractor (this contractor has the option of employing the General Contractor on the job to set the panels). 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 |

1.7 CUTTING AND PATCHING

- A. Each 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 in existing walls, omitted or are incorrect through failure of Mechanical Contractors to follow these instructions, 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. All cutting and patching of every nature required in connection with these Contracts shall be done by each Contractor with mechanics experience in their respective lines of work. All patching shall match adjacent finishes.
- D. All cutting in the building shall be done with great care so as not to leave an unsightly surface which may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through the fault of the Contractor, he shall be required at his own expense, to engage the General Contractor to replace the damaged materials with new materials.
- E. 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.
- F. 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.

1.8 GUARANTEE

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year 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.

1.9 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. The interior of all air handling equipment, ductwork and all filters shall be cleaned thoroughly before the building is accepted by the Owner.
- 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.

1.10 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. They shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation; including changes that affect the Contracts of other trades. 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. They 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.

1.12 APPROVED EQUALS

- 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 listed in the specifications as an approved equal. When providing an approved equal, the Contractor shall bear the responsibility of all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. They shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation; including changes that affect the Contracts of other trades. It shall be the responsibility of the Contractor to make certain that this equipment, which has been accepted by the Architect will fit into the designated spaces. They 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 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. They shall include such things as changes in piping, valves, supports and supporting structure, fittings, ductwork, motors, controls, electrical wiring and thermal insulation; including changes that affect the Contracts of other trades. It shall be the responsibility of the contractor to make certain the alternate equipment will fit into the designated spaces. They 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.

1.14 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.

1.15 OPERATIONS AND MAINTENANCE INSTRUCTIONS

- A. Upon the completion of this project, the Contractor shall deliver to the Architect for approval, three copies of an operating and maintenance manual consisting of the items outlined hereinafter.
- B. 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.
- C. 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.
- D. 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.
- E. 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.
 - 1. 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.
 - 2. All of the materials shall be indexed, arranged categorically and be bound in a rigid, plastic covered, three ring binder.

1.16 PAINTING

- A. Provide corrosion inhibiting prime coating on all ferrous materials.

END OF SECTION 230501

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 2000).
- 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; 2009, Revision 1 - 2010.
- 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; 2018.

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: www.lincolnmotors.com.
- D. A. O. Smith Electrical Products Company: www.aosmithmotors.com.

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
 - 1. TEFC 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. Motors for use with VFD's shall be designed and approved by the manufacturer for use with VFD's.
- D. Mechanical Contractor shall provide all motors and VFDs 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. 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 zerk 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.
- 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.

2.3 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 project.

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 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 this 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.

END OF SECTION 230513

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230514 – ADJUSTABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Adjustable frequency drives for HVAC fans.

1.2 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions apply to the Work of this Section.
- B. Section 23 0923 – Direct Digital Control (DDC) System.
- C. Section 23 0993 - HVAC Control Sequence.
- D. Refer to Divisions 00 and 01 for closeout submittals and additional warranty requirements.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Subject to compliance with the requirements of this section, provide adjustable frequency drives as manufactured by Yaskawa, Square D, Cutler Hammer, or ABB.
- 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. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

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. Manufacturer: AFD's shall be manufactured by ABB or pre-approved equal.
- C. Input Power: The AFD shall accept the specified input voltage within a $\pm 10\%$ variation.
- D. 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.
- E. 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.
- F. 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 valve.

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.
- G. 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.
- H. Multi-function output contacts programmable for any of the following indications:
1. Run mode
 2. Zero speed detect
 3. Overtorque 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.
- I. 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

- J. 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.
- K. Systems Integration: AFD manufacturer shall provide a compatible 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 manufacturer's 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.

3.4 SCHEDULE

- A. Air Handling Units:
 - 1. Provide adjustable frequency drives for both the supply fans for all RTU.

3.5 START-UP

- A. The contractor shall submit to the Owner, a fully completed start-up and test report for each AFD unit. The report shall include a list of all configured settings, values, and ranges. The report shall verify that the drive has successfully been tested at all

speeds, input and output signals are correct, and installation of unit is per manufacturer's instructions.

- B. The manufacturer shall be responsible for participating in the start up of their equipment and shall assist, as requested, with the work carried out by other HVAC equipment manufacturers, TAB firm and the BAS contractor.
- C. The AFD units will be functionally tested after the successful start-up and programming by the manufacturer, BAS contractor and TAB firm to determine the differential system pressure set points, fan/pump speeds and control ranges.
- D. Start up shall include the testing of the systems with the AFD's in simulated operating modes and verifying the accuracy, stability, and functions of the units. The manufacturer shall troubleshoot and make any adjustments or repairs on the AFD's as needed to support the tests without disrupting the schedule.
- E. The manufacturer shall provide on-site training to the Owner regarding the operation, adjustments and troubleshooting of the AFDs.

END OF SECTION 230514

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, equipment, insulation, and controls 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. Existing refrigerant shall be reclaimed and disposed of by the Contractor. 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 and exposed locations shall be by this Contractor unless specifically noted otherwise.
- D. The Owner shall have the option of keeping any or all salvageable items removed from building such as motors, control components, unit ventilator components, 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

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230519 – METERS AND GAGES FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Pressure gages and pressure gage taps.
 - 2. Thermometers and thermometer wells.
 - 3. Static pressure gages.
 - 4. Filter gages.

1.2 RELATED SECTIONS

- A. Section 23 0923 – Direct Digital Control (DDC) System.
- B. Section 23 0993 - HVAC Control Sequence.
- 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 REFERENCES

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 1998 (Pub. 2000).
- B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi; The American Society of Mechanical Engineers; 2004.
- C. ASTM E 1 - Standard Specification for ASTM Thermometers; 2005.
- D. ASTM E 77 - Standard Test Method for Inspection and Verification of Thermometers; 1998 (Reapproved 2003).
- E. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Underwriters Laboratories Inc.; 2005.
- F. UL 404 - Gages, Indicating Pressure, for Compressed Gas Service; Underwriters Laboratories Inc.; 2005.

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 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 (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.2 TEST PLUGS

- A. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F (176 degrees C).

2.3 STATIC PRESSURE GAGES

- A. Manufacturers:
 - 1. Omega Engineering, Inc: www.omega.com.
 - 2. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 - 3. Precision Instruments Company: www.picgauges.com.
- B. 3-1/2 inch (90 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

- C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch (6 mm) diameter tubing.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install thermometers in air duct systems on flanges.
- F. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 23 0923. 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.
- G. Locate duct mounted thermometers minimum 10 feet (3 m) downstream of mixing dampers, coils, or other devices causing air turbulence.
- H. Coil and conceal excess capillary on remote element instruments.
- I. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- J. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- K. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- L. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION 230519

THIS PAGE INTENTIONALLY LEFT BLANK

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 work specified in this Section include the following:
 - 1. Support isolation and restraints for motor driven Mechanical Equipment.
 - 2. Flexible connections for piping at Equipment.
 - 3. Flexible ductwork connections.
- C. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Division 1 – Summary of the Project.

1.2 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.
- E. Submit detailed drawings, drawn to the scale indicated, for each of the following installations. All drawings shall be based on the Architectural and Structural Contract Drawings.
 - 1. Mechanical Equipment rooms depicting size and location of concrete

housekeeping pads and the location and type of restraints. Minimum Scale: 1/4"=1'-0".

2. Concrete pad details depicting location and size of reinforcing, doweling, and anchor bolts for each specific piece of mechanical equipment. Minimum Scale: 1/2"=1'-0".
3. Suspended mechanical equipment and roof mounted mechanical equipment depicting restraint locations, types, and methods of attachment. Minimum Scale: 1/8"=1'-0".
4. Miscellaneous Attachment Details depicting size, locations, and types of attachment (i.e., bolts, welds, anchors, cables) for securing equipment to mountings and for securing mountings to the building structure.

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 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 restrained in accordance with requirements contained herein. All unisolated 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 structureborne 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 inches shall be zinc plated, or coated with a polyester epoxy powder. Springs with a rated deflection capability greater than 2 inches 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 1.00 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 FDS as manufactured by Kinetics.
 - D. The unit's internal isolators shall be kept in their bolted down position.
- 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 stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- D. Horizontal thrust restrains 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. or equivalent as manufactured by Taco, Inc.

2.15 BASES AND RAILS:

A. TYPE A - STRUCTURAL BASES:

- 1. Integral structural steel bases shall be rectangular in shape. All structural members shall be of wide flange, angle or channel steel with depth equal to a minimum of 1/10 of the longest span of equipment, but not less than 6 inches. Built-in adjustable motor slide rails and height saving brackets shall be supplied as an integral part of the base.
- 2. Integral structural steel bases shall be type WFB as manufactured by Vibration Mountings & Controls, Inc.

B. TYPE B - STRUCTURAL RAILS:

- 1. Structural steel rails shall be of the wide flange, angle or channel steel with depth equal to a minimum of 1/10 of the longest span of equipment, but not less than 6 inches. Height saving brackets shall be supplied as an integral part of the rails. Rails must be structurally attached to one another.
- 2. Structural steel rails shall be Type WFR as manufactured by Vibration Mountings & Controls, Inc.

C. 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.

D. TYPE D - ROOF CURB:

1. Provide welded 14 gauge galvanized steel shell and base plate curb with 1½" thick pound density rigid insulation and factory installed wood nailer. All plumbing and electrical connections to the equipment shall be flexible with water connections provided by double sphere neoprene union type flexible connections. Curb shall accommodate sloping steel where required.
2. Curb shall be as manufactured by Thybar, Pate or approved equal.
3. Provide curb with acoustical treatments.
 - a. Curb shall have 1" fiberglass absorber along inside perimeter of curb.
 - b. Provide 2" fiberglass absorber in bottom of curb.
 - c. Steel roof deck and roof insulation shall remain inside of curb.
4. Rails to support rooftop equipment shall be designed to provide isolation against the transmission of fabrications to the building structure. Rail assembly shall consist of extruded roll-formed top and bottom members with spring isolators incorporated and with a continuous air and water seal provided for the entire rail perimeter. Spring isolators shall be selected and spaced according to weight distribution.
 - a. Roof curb rails designed to be mounted atop curb systems shall be model ESR, as manufactured by Kinetics Noise Control (or pre-approved equal).

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 RESTRAINT SCHEDULE

A.	EQUIPMENT	TYPE	DEFLECTION
	1. Rooftop Units	D	1.00
	2. Condensing Units	3	0.75

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

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

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. For all installations, all floor mounted equipment, whether isolated or not, shall be bolted or welded to the structure. Bolt attachments, diameter of inserts, embedment depth and weld length as shown on approved submittal drawings, shall be followed in all respects.

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. Ductwork connections including provisions for flexible connections.
 3. 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. Offices, Libraries, Classrooms, Music etc.	3
b. Public Lobbies & Corridors	5
c. Workrooms, Storage, and Toilet Rooms	7
d. Mechanical Equipment Rooms	15

3.7 VIBRATION ELIMINATION:

- A. Vibration isolation supports shall be supplied for all moving or rotating equipment. Supports by Vibration Mountings and Controls, Inc. or approved in advance equal, installed in accordance with manufacturer's recommendations, shall be used unless specified otherwise herein.
- B. Rotating or moving machinery or equipment suspended from building structure shall be provided with approved resilient type suspension mounting with lock washer and double nuts.

- C. The entire system shall operate free from objectionable vibrations, to the satisfaction of the Engineer, Architect and Owner.

3.8 SOUND ISOLATION:

- A. All Equipment and piping shall be installed so that no noise or vibration is transmitted to any part of the building beyond the room or rooms in which such noise or vibration is generating. Silencers shall be installed in water connections to quick closing devices. Shock absorbers shall be used in all pipe lines where required to eliminate noise.

END OF SECTION 230549

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230554 – MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

- 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.
- B. Mechanical identification furnished as part of factory-fabricated equipment is specified as part of the equipment assembly 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.

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, the selection is the installer's option, but provide single selection for each product category.

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. 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.

END OF SECTION 230554

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Balancing work is to be included in the HVAC Contract. This Contractor will retain a third party balancing contractor.
- B. HVAC Contractor shall cooperate with the balancing contractor to properly adjust system components.
- C. HVAC Contractor shall include their cost to replace up to 25% of belts and sheaves to obtain specified air flows.

1.2 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.

1.3 REFERENCES

- 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.; 1988, with 1997 Errata.
- 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.

1.4 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 which 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. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE Std 111, or NEBB forms.
 - 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.
- i. Report date.

1.5 QUALITY ASSURANCE

- A. Perform total system balance in accordance with AABC MN-1, ASHRAE Std 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
 - 1. Maintain one copy of each document on site.
- B. TAB Agency Qualifications: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience certified by AABC or NEBB.
- C. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor experienced in performance of this Work and licensed at the Pennsylvania.

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.

3.2 TESTING, ADJUSTING, AND BALANCING AGENCIES

- A. H.T. Lyons, Inc.
- B. Associated Air Balance Engineers
- C. Optimum Performance Balancing
- D. Eastern Air Balance, Inc.
- E. Mountain Air Balancing.
- F. Butler Balancing.

3.3 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.

- B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- C. Beginning of work means acceptance of existing conditions.

3.4 INSTALLATION 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.

3.5 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.

3.6 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.
- 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.
- M. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.7 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. 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

D. 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. Saturated suction temperature, design and actual
11. Air pressure drop, design and actual

E. 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

F. 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

G. 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

H. 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

I. 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

J. Terminal Unit Data:

1. Manufacturer
2. Type(constant, variable, fan powered, 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

K. 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

L. Sound Level Reports:

1. Location
2. Octave bands - equipment off
3. Octave bands - equipment on

M. 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

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230714 – HVAC DUCT INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Duct insulation.
- B. Duct liner.
- C. Insulation jackets.

1.2 RELATED SECTIONS

- A. Section 23 0554 – Mechanical Identification.
- 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. 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 2015 - International Energy Conservation Code.
- J. IMC 2015 – International Mechanical 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 each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.
- D. 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, 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.
- C. All insulation and adhesives shall be formaldehyde free.
- D. Adhesives shall conform to the volatile organic compounds (VOC) limits set forth in the current edition of the South Coast Air Quality Management District Rule Number 1168 and as follows:

1. Adhesive Primer for Plastic: Adhesives shall not have VOC content in excess of 650 grams/liter.
 2. All Other Interior Applications: Adhesives shall not have VOC content in excess of 250 grams/liter.
- E. Sealants: Conform to the requirements of the January 1998 edition of the Bay Area Quality Management District Regulation 8, Rule 51 and as follows:
1. Interior Sealants: Interior sealants shall not have VOC content in excess of 250 grams/liter.
 2. Sealant Primers:
 - a. Nonporous interior sealant primers shall not have VOC content in excess of 250 grams/liter.
 - b. Porous interior sealant primers shall not have VOC content in excess of 775 grams/liter.

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: 250 degrees F (121 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.
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.

D. Vapor Barrier Tape:

1. 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. Manufacturers:

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 DUCT LINER

A. Manufacturers:

1. Knauf Insulation Sonic XP Duct Liner
2. Pre-approved equal.

B. Flexible, mat-faced bonded insulation with encapsulant edge coating.

1. Thermal performance: 1.5" thickness; R-value 6.0 (hr-sqft-F/Btu) or 0.17 conductance.
2. Service temperature: up to 250 degrees F (121 degrees C).
3. Rated velocity on coated air side for air erosion: 6,000 fpm minimum.
4. Minimum noise reduction coefficients; 1.5 inch (25 mm) thickness: 0.80.

C. Install and fasten per manufacturer's recommendations.

2.5 FLEXIBLE BLANKET FIREPROOFING:

- A. Manufacturers:
 - 1. 3M Fire Parrier Grease Duct Wrap
 - 2. Approved Equal.
- B. Material: high temperature soluble fiber blanket encapsulated in scrim reinforced aluminum foil covering.
- C. Weight: 0.75 lb/sf
- D. Systems: Ducts requiring 2 hour fire rating.
- E. Combustibility (ASTM E-136): Noncombustible.

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.
 - 6. External Duct Insulation Application:
 - a. 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.
 - b. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier

- c. adhesive.
 - c. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 - d. Install Insulation materials with smooth and even surfaces.
 - e. Maintain integrity of vapor barrier on ductwork insulation, and protect it to prevent puncture and other damage.
 - f. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations except where otherwise indicated.
7. Duct and Plenum Liner Application:
- a. Adhere insulation with adhesive for 100 percent coverage.
 - b. Secure insulation with mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for spacing.
 - c. Seal and smooth joints. Seal and coat transverse joints.
 - d. Seal liner surface penetrations with adhesive.
 - e. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
 - f. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.
8. 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.

3.3 SCHEDULES

- A. Ducts shall be acoustically (internally) lined where indicated on the plans.
- B. Where ducts are internally lined for acoustical treatment, no additional outside duct insulation shall be required.
- C. All supply air ductwork of air conditioning systems shall be externally insulated unless noted to be internally lined, except where ductwork is installed exposed in the conditioned space.
- D. Return and exhaust air ductwork of air conditioning systems shall be insulated wherever the ductwork runs under a roof. Insulation shall be external unless noted to be lined.
- E. All exhaust and relief air ducts shall be externally insulated from the backdraft device or ATC damper to the louver. All exhaust ductwork from the heat recovery units shall be externally insulated from the unit to the louver.
- F. Dual Temperature Ductwork:
 - 1. Application Requirements: Where leaving air temperature is alternately above

and below ambient temperature insulate and vapor seal ductwork, except where ductwork is indicated to be acoustically lined.

- G. Externally Insulated Ductwork: Provide with one of the following types and thicknesses of insulation, except as otherwise indicated:
1. Insulation: Rigid mineral fiber, 3 PCF in concealed areas, 6 PCF in exposed areas, supply and return ducts – 1" thick, outside air ducts – 2" thick.
 2. Insulation: Flexible mineral fiber, 2" thick, application limited to concealed locations. Density shall be 1.5 pounds/cubic foot.
- H. Lined Ductwork:
1. 1.5" thick flexible glass fiber with black pigmented fire-resistant coating on air steam.
 2. See drawings for locations of duct liner.

END OF SECTION 230714

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment and installation for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-furnished controls.
- B. See "Sequences of Operation" for requirements that relate to this Section.

1.2 DEFINITIONS

- A. DDC: Direct digital controls
- B. IP: Internet Protocol
- C. I/O: Input/Output
- D. LAN: Local area network.
- E. MS/TP: Master-slave/token-passing. Refer to AHSRAE standard 135-2010
- F. TCP: Transfer Control Protocol
- G. Scope Terminology
 - 1. Provide = Furnish equipment, engineer, program and install
 - 2. Furnish = Furnish equipment, engineer and program
 - 3. Mount = securely fasten or pipe
 - 4. Install = mount and wire
 - 5. Wire = wire only

1.3 SYSTEM DESCRIPTION

- A. The Building Automation System (BAS) contractor shall furnish and install a networked system of HVAC controls. The contractor shall incorporate direct digital control (DDC) for central plant equipment, building ventilation equipment, supplemental heating and cooling equipment, and terminal units.
- B. Provide networking to new DDC equipment using communication standards. System shall be capable of BACnet communication according to ASHRAE standard ANSI/ASHRAE 135-2010 for interoperability with smart equipment and for the main IP communication trunk to the BAS Server.

- C. All new BAS Controllers shall be BTL Certified and integrated into the BACnet Advanced Workstation Software (BTL B-AWS) interface in the district, Metasys. This graphical package allows maintenance personnel to monitor, view, and command all controls in the district from a single user interface. All graphics shall comply with school district site standards.
- D. The work includes new control systems for new HVAC systems (RTU, EF, VAV, FPV units) **as well as** the field installation of new controls on the two existing RTU as required to accomplish the specified sequence and integrate the existing units into the new building automation system.

1.4 WORK INCLUDED

- A. 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.
- B. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:
 - 1. Provide a submittal that meets the requirements below for approval.
 - 2. Coordinate installation schedule with the mechanical contractor and general contractor.
 - 3. Provide installation of all panels and devices unless otherwise stated.
 - 4. Provide power for panels and control devices.
 - 5. Provide all low voltage control wiring for the DDC system.
 - 6. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
 - 7. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
 - 8. Participate in commissioning for all equipment that is integrated into the BAS (Refer to Commissioning sections of the equipment or systems in other parts of this specification.)
 - 9. Provide testing, demonstration and training as specified below.

1.5 SUBMITTALS

- A. Provide submittals for fast-track items that need to be approved and released to meet the schedule of the project. Provide submissions for the following items separately:
 - 1. Valve schedule and cut sheets
 - 2. Factory mounting and wiring diagrams and cut sheets
 - 3. Thermostat locations
- B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:

1. Schematic flow diagrams showing fans, coils, dampers, valves, and control devices.
 2. Wiring Diagrams: Power, signal, and control wiring.
 3. Details of control panel faces, including sizes, controls, instruments, and labeling.
 4. Schedule of dampers and actuators including size, leakage, and flow characteristics.
 5. If dampers are furnished by other, submit a damper actuator schedule coordinating actuator sizes with the damper schedule.
 6. Schedule of valves including leakage and flow characteristics.
 7. Written description of the Sequence of Operations.
 8. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses. Show all routers, switches, hubs and repeaters.
 9. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
 10. Starter and variable frequency drive wiring details of all automatically controlled motors.
 11. Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.
- C. 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.
- D. Wiring Diagrams: 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.
- E. Submit blank field check-out and commissioning test reports, customized for each panel or system, which will be filled out by the technician during start-up.

1.6 QUALITY ASSURANCE

A. Codes

1. Perform all wiring in accordance with Division 26, NEC, local codes and Owner's requirements.
2. Uniform Building Code (UBC)
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
5. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems,

6. Provide UL 864 – UUKL Smoke Control, where controllers and networks are used for that purpose.
 - a. Provide written approvals and certifications after installation has been completed.
7. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
8. 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.

B. Qualifications

1. Installing contractor shall be in the business of installing and servicing DDC controls for mechanical systems, temperature and ventilation control, environmental control, lighting control, access and security controls, and energy automation as their primary business. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.
2. Engineering, drafting, programming, and graphics generation shall be performed by the local branch engineers and technicians directly employed by the Building Automation System Contractor.
3. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.

C. The BMS contractor shall maintain a service organization consisting of factory trained service personnel and provide a list of ten (10) projects, similar in size and scope to this project, completed within the last five years.

D. Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.

1.7 COORDINATION

- A. Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.
- B. Coordinate power for control units and operator workstation with electrical contractor.
- C. Coordinate equipment with provider of starters and drives to achieve compatibility with motor starter control coils and VFD control wiring.

- D. Coordinate scheduling with the mechanical contractor and general contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.
- E. Products Furnished but Not Installed Under This Section
 - 1. Sheetmetal accessories
 - a. Dampers
 - b. Airflow Stations
- F. The following is a list in which represents interoperable controllers either provided by the BAS Contractor for field installation or interoperable controllers factory provided/wired/programmed by equipment manufacturer. BAS Contractor is to coordinate any MFG provided loosely shipped devices that require field installation.

EQUIPMENT TYPE	CONTROLLER	INSTALLATION METHOD
Variable Volume Box (VAV)	BAS	Factory Mounted
Unit Heater (UH/EWH/CH)	BAS	Field Mounted
Variable Volume Roof Top Unit (RTU)	BAS	Field Mounted
Ductless Split Systems (DSS)	MFG	Factory Mounted / Field Monitor
Lighting Control System	MFG	Integration
Miscellaneous Monitoring - Generator	-	Display at Front End (Coordinate with MFGs)

- H. For any controller and equipment installation method noted to be provided by BAS Contractor and Factory Mounted the equipment shall be factory tested and the following shall apply:
 - 1. The ATC contractor will provide all controllers, actuators, and ATC sensors to accomplish the specified sequence, and points specified. All controllers, actuators and ATC sensors will be shipped to the manufacturer for factory installation and wiring prior to unit testing. The manufacturer shall provide factory wiring diagrams to ATC contractor approval for approval. Controls and safeties associated with units' refrigeration cycle shall be provided by the manufacturer and include BACNET interface.
 - 2. The manufacturer shall complete all component functional testing prior to unit shipment. Factory service representative shall provide functional test reports for engineer review. Functional test report to include: Each compressor operating conditions at 30 Hz, 60 Hz, and 90 Hz, refrigerant microns vacuum test, refrigerant quantity installed, Fan VFD operation and factory settings quality control report.

1.8 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.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

- A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- B. The Building Management System shall consist of the following:
 - 1. Standalone Network Automation Engine(s)
 - 2. Field Equipment Controller(s)
 - 3. Input/Output Module(s)
 - 4. Local Display Device(s)
 - 5. Portable Operator's Terminal(s)
 - 6. Distributed User Interface(s)
 - 7. Network processing, data storage and communications equipment
 - 8. Other components required for a complete and working BMS
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
 - 1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
 - 2. The System shall maintain all settings and overrides through a system reboot.
- E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
- F. Acceptable Manufacturers
 - 1. Johnson Controls, Metasys Branch Office Only – Mike Turriziani 610-247-6062 (mike.turriziani@jci.com).

2.2 BAS NETWORK

A. Dedicated Web Based User Interface

1. Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
 - a. Microsoft Internet Explorer for user interface functions
 - b. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
 - c. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
 - d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries

B. Distributed Web Based User Interface

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser supporting the following functions:
3. Minimum hardware requirements:

C. Site Management User Interface Application Components

1. Operator Interface
 - a. An integrated browser based client application shall be used as the user operator interface program.
 - b. The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.
 - c. All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
 - d. The user interface software shall provide help menus and instructions for each operation and/or application.
 - e. The system shall support customization of the UI configuration and a home page display for each operator.
 - f. The system shall support user preferences in the following screen presentations:

- 1) Alarm
 - 2) Trend
 - 3) Display
 - 4) Applications
- g. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
- h. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.
2. Navigation Trees
- a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
 - b. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
 - c. The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.
3. Alarms
- a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - b. The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
 - c. The BMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.
 - d. The BMS shall annunciate application alarms at minimum, as required by Part 3.
4. Reports and Summaries
- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
 - c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

- d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

5. Schedules

- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - 1) Weekly schedules
 - 2) Exception Schedules
 - 3) Monthly calendars
- b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
- c. It shall be possible to define one or more exception schedules for each schedule including references to calendars

D. Series Network Engines (SNE)

- 1. The Series Network Engine (SNE) shall be a fully user-programmable, supervisory controller. The SNE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
- 2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
 - a. The web based user shall have the capability to access all system data through one SNE.
 - b. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one SNE.
 - c. Systems that require the user to address more than one SNE to access all system information are not acceptable.
 - d. The SNE shall have the capability of generating web based MUI graphics. The graphics capability shall be imbedded in the SNE.
 - e. Systems that support MUI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - f. Systems that require workstation software or modified web browsers are not acceptable.
 - g. The SNE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

2.3 DDC SYSTEM CONTROLLERS

A. General Purpose Controller (CGM)

- 1. The General Purpose Controller (CGM) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
 - a. The CGM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

- 1) The CGM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - 2) The CGM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - 3) A BACnet Protocol Implementation Conformance Statement shall be provided for the CGM.
 - 4) The Conformance Statement shall be submitted 10 days prior to bidding.
2. The CGM shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

~~B.~~ B. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

2.4 FIELD DEVICES

A. VAV Controllers (CVM)

1. The VAV Controllers shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
2. The CVM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The CVM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the CVM The Conformance Statement shall be submitted 10 days prior to bidding.
3. The CVM Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.

B. Network Sensors (NS-XXX-700X)

1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - a. Zone Temperature
 - b. Zone Humidity
 - c. Zone Setpoint
 - d. Discharge Air Temperature
 - e. Zone CO2

2.5 INPUT DEVICES

A. Power Monitoring Devices

1. Current Measurement (Amps)
 - a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
 - b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
 - 1) Operating frequency – 50 - 400 Hz.
 - 2) Insulation – 0.6 Kv class 10Kv BIL.
 - 3) UL recognized.
 - 4) Five amp secondary.
 - 5) Select current ration as appropriate for application.
 - 6) Acceptable manufacturers: Veris Industries
 - c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
 - 1) 6X input over amp rating for AC inrushes of up to 120 amps.
 - 2) Manufactured to UL 1244.
 - 3) Accuracy: +.5%, Ripple +1%.
 - 4) Minimum load resistance 30kOhm.
 - 5) Input 0-20 Amps.
 - 6) Output 4-20 mA.
 - 7) Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
 - 8) Acceptable manufacturers: Veris Industries
- B. Smoke Detectors
 1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 16 for installation under Division 15. All wiring for air duct detectors shall be provided under Division 16, Fire Alarm System.
- C. Status and Safety Switches
 1. General Requirements
 - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
 2. Current Sensing Switches
 - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

- c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - d. Acceptable manufacturers: Veris Industries
- 3. Air Filter Status Switches
 - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. A complete installation kit shall be provided, including: static pressure taps, tubing, fittings, and air filters.
 - c. Provide appropriate scale range and differential adjustment for intended service.
 - d. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 4. Air Flow Switches
 - a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
 - b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 5. Air Pressure Safety Switches
 - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - c. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 6. Low Temperature Limit Switches
 - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
 - d. The low temperature limit switch shall be equal to Johnson Controls A70.

2.6 OUTPUT DEVICES

A. Actuators

- 1. General Requirements
 - a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
- 2. Electronic Damper Actuators
 - a. Electronic damper actuators shall be direct shaft mount.

- b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
- c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
- e. Acceptable manufacturers: Johnson Controls, Mamac.

B. Control Dampers

- 1. The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.
- 2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- 3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- 4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, and Vent Products 5650.
6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls D-1600, Ruskin CD36, and Vent Products 5800.
7. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays

1. Control Pilot Relays

- a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
- b. Mounting Bases shall be snap-mount.
- c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
- d. Contacts shall be rated for 10 amps at 120VAC.
- e. Relays shall have an integral indicator light and check button.
- f. Acceptable manufacturers: Johnson Controls, RIB

2.7 CONTROL PANELS

- A. Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.
- B. Mount on walls at an approved location or provide a free-standing rack.
- C. Panels shall be constructed of 16 gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 gray polyester-powder painted finish, UL listed. Provide common keying for all panels.
- D. Provide power supplies for control voltage power. Power Supplies for Building Level Controllers shall be a transformer with a fuse or breaker. Power supplies for other devices can be a plain transformer.

2.8 GRAPHICAL INTERFACE

- A. Incorporate all new equipment added as a result of this project into the building automation system. This will allow for the school district's facility management staff to graphically monitor and control the building. Users shall be able to schedule and modify mechanical equipment schedules as well as collect, view, and make management decisions with information and reporting capabilities.

- B. Provide a main default screen showing the basic layout of the building. Each color graphic screen shall have transfer links to allow the building operator to transfer between system associated screens (both forward and backward), as well as a transfer link back to the main default screen.
- C. All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BAS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading (preferred set point on top and actual reading on bottom). All points shall indicate the associated engineering unit. All analog outputs points shall indicate engineering units such as "%-open" or "%-closed" as required by the application.
- D. Provide system color graphics for each HVAC system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service, and system data as required.
- E. Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers.

2.9 SENSORS

- A. Terminal Unit Space Temperature Sensors
 - 1. Each controller performing space temperature control shall be provided with a matching room temperature sensor.
 - a. The sensing element for the space temperature sensor shall be thermistor type providing the following.
 - 1) Element Accuracy: + /- 1.0°F
 - 2) Operating Range: 55 to 95°F
 - 3) Set Point Adjustment Range: 55 to 95°F
 - 4) Setpoint Adjustment Dial
 - 5) Occupancy Override Switch
 - b. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.
 - c. All space sensors shall be wired to the associated terminal unit controller – wireless sensors are not acceptable.
 - 2. Provide the following options as they are called for in the sequences or on the drawings:
 - a. Setpoint Adjustment. The setpoint adjustment function shall allow for modification of the temperature by the building operators. Setpoint adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central

workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.

- b. Override Switch. An override button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.

B. Temperature Sensors

1. Insertion Elements in Ducts shall meet the following specifications:
 - a. Temperature Monitoring Range: +20 °F – 120 degF °F
 - b. Accuracy at Calibration Point: + /- 0.5 °F
 - c. Use where not affected by temperature stratification
 - d. The sensor shall reach more that 1/3 the distance from the duct wall
2. Averaging Elements in Ducts shall meet the following specifications:
 - a. Temperature Monitoring Range: +20 °F – 120 degF °F
 - b. Accuracy at Calibration Point: + /- 0.5 °F
 - c. Flexible
 - d. Use where prone to temperature stratification or in front of coils

C. Humidity Sensors shall meet the following specifications:

1. Bulk polymer sensor element
2. Accuracy: 5 percent full range with linear output
3. Room Sensor Range: Span of 0 to 100 percent relative humidity

D. Air Static Pressure Transmitter shall meet the following specifications:

1. Non-directional sensor with suitable range for expected input, and temperature compensated.
2. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
3. Output: 4 to 20 mA.
4. Building Static-Pressure Range: 0 to 0.25 inches wg.
5. Duct Static-Pressure Range: 0 to 5 inches wg.

E. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

F. Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5 amp switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. These switches shall be utilized for filter status.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

3.2 INSTALLATION

- A. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.
- B. Unless otherwise noted, install wall mounted thermostats and humidistat 48" above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.
- C. Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.
- D. Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.
- E. Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.
- F. Furnish automatic dampers to mechanical contractor for installation.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be provided in accordance with all local and national codes and as described below:
 - 1. All wiring associated with the installation will be the responsibility of this Contractor, unless otherwise directed herein.. The term "wiring" is construed to include furnishing of wire, conduit, miscellaneous material and labor as required, to install a total working system.
 - 2. All low voltage (30V and below) wiring above accessible, concealed and dry locations may be run in plenum-rated cable without conduit (must be independently supported every 5 feet with bridle rings or other method approved by the consulting engineer). All low voltage wiring in mechanical spaces or electric/telephone closets must be run in electric metallic tubing (EMT), 3/4-inch or greater. All indoor wiring 30vac or greater shall be run in EMT conduit. All outdoor wiring shall be run in rigid metallic conduit. Seal tight may be used within 6 feet of the final connection to the device or panel.
 - 3. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor.
 - 4. Wiring for controls furnished by others:
 - a. Provide control wiring for HVAC controls furnished by others. Wiring may include, but not limited to, the following items:
 - 1) Thermostats

- 2) Interlock wiring between split system AC units and their associated condensing unit
- 3) Chiller & Boiler control devices shipped loose

3.4 START-UP AND COMMISSIONING

- A. When installation of the system is complete, calibrate equipment and verify transmission media before system is placed on-line. All testing, calibrating, adjusting, and final field tests shall be completed by the BAS contractor.
- B. Perform a two-phase commissioning procedure consisting of field I/O calibration and overall system sequence of operation commissioning. Document that each point was verified and operating correctly on commissioning sheets, which shall be submitted prior to acceptance testing. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed.

3.5 PROJECT RECORD DOCUMENTS

- A. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
 1. Complete as-built installation drawings for each building system.
 2. Parts list with manufacturer's catalog numbers and ordering information.
 3. Manufacturer's catalog literature for each piece of equipment.
 4. Sequence of operation for automatic and manual operating modes for all building systems.

3.6 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.
- B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 8-hours 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

THIS PAGE INTENTIONALLY LEFT BLANK

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.

1.3 RELATED SECTIONS:

- A. Section 230923 – Direct Digital Control (DDC).
- B. Appendix – Refer to the Appendix of this section for a sample points list. The points list is included merely as a guide and is representative of a single equipment item. The points list does not quantify the number of points for all equipment provided under Division 23. Points shall be provided to carry out the sequences described herein to make a complete operating Building Automation System (BAS).
- C. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Division 1 – Summary of the Project.

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 Automation System (BAS) user interface. An alarm shall be generated on the BAS when the Zone is selected as "Override".

Provide a separate zone for each heat recovery unit, rooftop air handling unit, and air handling unit. Zone names to be coordinated with the Owner and Engineer.

- 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 OCCUPIED-UNOCCUPIED CYCLES:

- A. When any zone is indexed to the night cycle, all air handling/heat recovery 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.

2.3 WARM-UP OR COOL-DOWN CYCLE:

- A. For all air conditioning units and air handlers, provide the necessary devices required to keep the outside air dampers closed during the warm-up and cool-down cycles prior to occupancy as determined by the optimum start algorithm.

2.4 ROOFTOP AIR HANDLING UNITS –MULTI-ZONE VAV

- A. Air handlers are equipped with supply air fans, relief air fans, outside air/return air dampers, electric heating coil, DX cooling coils, compressors and condensing fans. Air handler shall be indexed to the occupied, unoccupied and warmup modes from the Building Automation System (BAS) 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. Relief Fan Control: Provide a pressure sensor (adj.) within the space that shall, through the DDC controller, modulate the speed of the relief air fan via the VFD in order to maintain a constant pressure.
- D. 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 return air temperature up to occupied set-point. Heating valve shall be open and outside air damper shall be closed. VAV box dampers shall be controlled to close on rising temperature above 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 Building Automation System. On a fall in supply air temperature below the heating set-point, the electric heating coil shall energize and the outside air damper remains at minimum position. On a rise in supply air temperature, the electric heating coil shall de-energize.
2. The supply air temperature shall optimized to satisfy the room with the largest cooling demand.
3. On a 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 DX system shall energize for cooling. On a fall in space temperature, the reverse shall occur.
4. If free cooling is not available as determined by outdoor air enthalpy, the outside air damper shall remain at minimum open position and the DX system shall modulate for cooling as required.
5. Dehumidification: Upon a rise in humidity above the space humidity set-point, the DX system shall energize. The hot gas reheat coil shall engage to maintain discharge temperature. Upon a drop in space humidity, normal control shall be restored.

F. Unoccupied Cycle:

1. The outside air dampers shall remain closed while the fan cycles with the heating coil and DX cooling modulate to maintain the adjustable setback and setup set-points. The fan-powered VAV boxes shall provide the first stage of unoccupied heating. The unit unoccupied heating sequence shall only engage when a low-limit temperature is reached within the building (less than 60 deg F, adjustable).
2. Dehumidification: Upon a rise in humidity above the space humidity set-point, the DX system shall energize. The hot gas reheat coil shall engage to maintain discharge temperature. Upon a drop in space humidity, normal control shall be restored.

G. Safeties:

1. During both occupied and unoccupied cycles, an averaging air temperature sensor shall act to override the heating coil 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 provided by the Electrical Contractor and control shutdown wiring shall be provided by this contractor. 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 Building Automation 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 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 RTU 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 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 55°F (adj.). Hot gas reheat will energize to maintain discharge temperature as described in the dehumidification sequence.
 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.
- 2.5 SHUTOFF VAV BOX CONTROL (VAV):
- 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 BAS according to its respective zone signal.
 - B. During the unoccupied cycle the VAV box primary air damper shall be allowed to be fully closed.
 - 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 reheat coil to maintain the room temperature at setpoint. While the reheat coil is being utilized for heating, the box primary supply damper shall remain at the minimum design CFM.
 - D. Room Sensors:

1. The room temperature/humidity sensor shall have a setpoint adjustment knob with a software definable adjustable range (e.g. +/- 2 deg F).
2. All sensor inputs and actuator outputs from the controller shall be available throughout the Building Automation System.

2.6 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 coil 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.
- 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 coil shall stage to maintain set-point temperature.
- D. Room Sensors:
 1. All sensor inputs and actuator outputs from the controller shall be available throughout the Direct Digital Control System.

2.7 EXHAUST FAN CONTROL:

- A. Those exhaust fans noted "ATC" 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 Building Automation 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. Those exhaust fans noted "Switch" or "Interlock" on the schedule shall be controlled based upon a status signal from the DDC system. When a switch is on or the interlock is engaged the fan shall energize. When the switch is turned off or the interlock is disengaged the fan shall de-energize.

2.8 CABINET UNIT HEATER AND UNIT HEATER CONTROL:

- A. Provide a space temperature sensor for control of each cabinet unit heater. The sensor shall be controlled through the DDC system and be indexed to occupied or unoccupied

cycle based upon its respective zone signal. 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 electric heating coil shall energize.

2.9 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 BAS if elevated temperatures are sensed.

2.10 EMERGENCY GENERATOR:

- A. Interface with the generator system to provide a summary alarm on the BAS to indicate failure or trouble alarms. Indicate when the generator is operating.

2.11 DOMESTIC HWH:

- A. Provide monitoring of domestic water supply temperature.

2.12 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.

2.13 INVERTER:

- A. BAS system shall monitor the inverter. The inverter shall be provided by the E.C. with a BACnet gateway for integration.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Refer to the 230923 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

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. Pressure relief valves.
- G. Filter-driers.
- H. Solenoid valves.
- I. Expansion valves.
- J. Receivers.
- K. Flexible connections.

1.2 RELATED SECTIONS

- A. Section 23 0993 – HVAC Control Sequence.
- B. Section 23 8127 - Small Split-System heating and cooling
- C. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with section – Summary of the Project.

1.3 REFERENCES

- A. ARI 495 - Refrigerant Liquid Receivers; Air-Conditioning and Refrigeration Institute; 2005.
- B. ARI 710 - Performance Rating of Liquid-Line Dryers; Air-Conditioning and Refrigeration Institute; 2004.

- C. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Driers; Air-Conditioning and Refrigeration Institute; 2005.
- D. ARI 750 - Thermostatic Refrigerant Expansion Valves; Air-Conditioning and Refrigeration Institute; 2001.
- E. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants; Air-Conditioning and Refrigeration Institute; 2001.
- F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2004.
- G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2004.
- H. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2004.
- I. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- J. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes; The American Society of Mechanical Engineers; 1988.
- K. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2001.
- L. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2004 (ANSI/ASME B31.9).
- M. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2005.
- N. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2005a.
- O. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.
- P. ASTM B 280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2003.
- Q. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.
- R. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2006.
- S. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2002.

- T. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- U. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- V. UL 429 - Electrically Operated Valves; Underwriters Laboratories Inc.; 1999.

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.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.
- D. Valves:
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gage taps at compressor inlet and outlet.
 - 3. Use gage taps at hot gas bypass regulators, inlet and outlet.
- E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- F. Strainers:
 - 1. Use line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
 - 3. On steel piping systems, use strainer in suction line.
 - 4. Use shut-off valve on each side of strainer.
- G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
- H. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

- I. Solenoid Valves:
 - 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
 - 2. Use in liquid line of single or multiple evaporator systems.
 - 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- J. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturer's 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. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
- H. Maintenance Data: Include instructions for changing cartridges, assembly views, and spare parts lists.

1.6 QUALITY ASSURANCE

- A. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Pennsylvania.

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.

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.

1.9 MAINTENANCE PRODUCTS

- A. Provide two refrigeration oil test kits each containing everything required to conduct one test.
- B. Provide two filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.1 PIPING

- A. Copper Tube: ASTM B 280, H58 hard drawn or O60 soft annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.
- B. Copper Tube to 7/8 inch (22 mm) OD: ASTM B 88 (ASTM B 88M), Type K (A), annealed.
 - 1. Fittings: ASME B16.26 cast copper.
 - 2. Joints: Flared.
- C. Pipe Supports and Anchors:
 - 1. Conform to ASME B31.5.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 Inches (75 mm): Cast iron hook.
 - 6. Wall Support for Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 - 7. Vertical Support: Steel riser clamp.

8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
10. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
11. 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.

2.2 REFRIGERANT

- A. Refrigerant: R-134a, tetrafluoroethane as defined in ASHRAE Std 34.
- B. Refrigerant: R-410a as defined in ASHRAE Std 34.

2.3 MOISTURE AND LIQUID INDICATORS

- A. 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 (93 degrees C) and maximum working pressure of 500 psi (3450 kPa).

2.4 VALVES

- A. Packed Angle Valves:
 1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).
- B. Ball Valves:
 1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 300 degrees F (149 degrees C).
- C. 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 (3450 kPa).

2.5 STRAINERS

A. Straight Line or Angle Line Type:

1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi (2960 kPa).

2.6 CHECK VALVES

A. Globe Type:

1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F (149 degrees C) and maximum working pressure of 425 psi (2930 kPa).

2.7 PRESSURE REGULATORS

- ### A.
- Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi (0 to 550 kPa) range, for maximum working pressure of 450 psi (3100 kPa).

2.8 PRESSURE RELIEF VALVES

- ### A.
- Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi (1620 kPa).

2.9 FILTER-DRIERS

A. Performance:

1. Pressure Drop: 2 psi (14 kPa), maximum, when operating at full connected evaporator capacity.
2. Design Working Pressure: 350 psi (2410 kPa), 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. Connections: As specified for applicable pipe type.

2.10 SOLENOID VALVES

- A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi (3450 kPa).
- B. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.11 EXPANSION VALVES

- A. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.12 FLEXIBLE CONNECTORS

- A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches (230 mm) long with copper tube ends; for maximum working pressure of 500 psi (3450 kPa).

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. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- G. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
- H. 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.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- K. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- L. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- M. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- N. 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 (1380 kPa). Perform final tests at 27 inches (92 kPa) vacuum and 200 psi (1380 kPa) using halide torch. Test to no leakage.

END OF SECTION 232300

SECTION 233100 – HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Casing and plenums.
- C. Duct cleaning.

1.2 RELATED SECTIONS

- A. Division 9 - Painting and Coating: Weld priming, weather resistant, paint or coating.
- B. Section 23 0714 - Duct Insulation.
- C. Section 23 3300 - Air Duct Accessories.
- D. Section 23 3600 - Air Terminal Units.
- E. Section 23 3700 - Air Outlets and Inlets.
- G. 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. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2005a.
- B. ASTM A 1008/A 1008M - 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 Hardened; 2005b.
- C. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability; 2005a.
- D. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2004.
- E. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2004.

- F. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 2002.
- G. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2004.
- H. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 1985, First Edition.
- I. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; 2005.
- K. IMC 2015 – International Mechanical Code.

1.4 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.5 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 all systems.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.
- F. Adhesives: Provide data for each intended application from the manufacturer of adhesives indicating the volatile organic compound (VOC) content, as measured in grams/liter.
- G. Sealants: Provide data for each intended application from the manufacturer of sealants indicating the volatile organic compound (VOC) content, as measured in grams/liter.

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.

1.7 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A standards.
- B. All closure systems shall comply with IMC 2015 and UL 181A.

1.8 ENVIRONMENTAL REQUIREMENTS

- 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.
- C. Adhesives: Conform to the volatile organic compounds (VOC) limits set forth in the current edition of the South Coast Air Quality Management District Rule Number 1168 and as follows:
 - 1. Adhesive Primer for Plastic: Adhesives shall not have VOC content in excess of 650 grams/liter.
 - 2. All Other Interior Applications: Adhesives shall not have VOC content in excess of 250 grams/liter.
- D. Sealants: Conform to the requirements of the January 1998 edition of the Bay Area Quality Management District Regulation 8, Rule 51 and as follows:
 - 1. Interior Sealants: Interior sealants shall not have VOC content in excess of 250 grams/liter
 - 2. Sealant Primers:
 - a. Nonporous interior sealant primers shall not have VOC content in excess of 250 grams/liter.
 - b. Porous interior sealant primers shall not have VOC content in excess of 775 grams/liter.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS

Type B, with G60/Z180 coating.

- B. Steel Ducts: ASTM A 1008/A 1008M, Designation CS, cold-rolled commercial steel.
- C. Aluminum Ducts: ASTM B 209 (ASTM B 209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- D. Insulated Flexible Ducts:
 - 1. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
 - a. Pressure Rating: 10 inches WG (2.50 kPa) positive and 1.0 inches WG (250 Pa) negative.
 - b. Maximum Velocity: 4000 fpm (20.3 m/sec).
 - c. Temperature Range: -10 degrees F to 160 degrees F (-23 degrees C to 71 degrees).

2.2 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. 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. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide insulated blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.3 DUCT MANUFACTURERS

- A. Metal-Fab, Inc.
- B. SEMCO Incorporated.
- C. United McGill Corporation.
- D. Wm. H. Brady Incorporated.

2.4 MANUFACTURED METAL DUCTWORK AND FITTINGS

- A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, 1 inch (25 mm) thick fiberglass insulation, perforated galvanized steel inner wall; fitting with solid inner wall. Double wall ducts shall be of, at minimum, 18 gauge thick construction.
- C. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
- D. Double Wall Rectangular Ducts: Rectangular double wall ducts shall have a solid galvanized steel outer shell and a perforated inner liner, separated with a 1.5" thick fiberglass insulating layer. Fittings shall have solid inner walls. Double wall ducts shall be 18 gauge thick construction.

2.5 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch (100 mm) high concrete curbs. At floor, rivet panels on 8 inch (200 mm) centers to angles. Where floors are acoustically insulated, provide liner of 18 gage (1.20 mm) galvanized expanded metal mesh supported at 12 inch (300 mm) centers, turned up 12 inches (300 mm) 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. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- B. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Provide openings in ductwork where required to accommodate thermometers and

controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

- D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Tape joints of PVC coated metal ductwork with PVC tape.
- G. Connect terminal units to supply ducts directly or with one foot (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.
- H. Connect flexible ducts to metal ducts with adhesive, draw bands.
- I. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
- J. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

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. All supply, return and exhaust systems shall be leakage tested to 1.5 times the design static pressure or SMACNA requirement (whichever is greater). Perform leakage test for kitchen grease duct systems.

3.3 CLEANING

- A. 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.

3.4 SCHEDULES

A. Ductwork Material:

1. Low Pressure Supply (Heating Systems): Galvanized Steel.
2. Low Pressure Supply (System with Cooling Coils): Galvanized Steel.
3. Medium and High Pressure Supply: Galvanized Steel.
4. Return and Relief: Galvanized Steel.
5. General Exhaust: Galvanized Steel.
6. Exposed Ductwork shall be paint grip type.

B. All accessories (dampers, fittings, etc.) shall be of the material specified in 3.4.A.

3.5 PRESSURE CLASS

A. Provide ductwork gauge thickness in accordance with SMACNA for the following pressure class schedule:

1. VAV supply from the unit fan to the terminal device: +/- 4" WG.
2. VAV return: +/- 2" WG.
3. VAV supply from the terminal device to the diffuser: +/-2" WG.
4. Toilet exhaust: +/- 2" WG.
5. Additional systems (not including transfer air ducts +/-2" WG.
6. Transfer air ducts +/-1" WG.

END OF SECTION 233100

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers.
- C. Combination fire and smoke dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers.
- G. Flexible duct connections.
- H. Smoke dampers.
- I. Volume control dampers.

1.2 RELATED SECTIONS

- A. Section 23 3100 - HVAC Ducts and Casings.
- B. Section 23 3600 - Air Terminal Units.
- 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 REFERENCES

- A. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 2002.
- B. NFPA 92A - Standard on Smoke-Control Systems; National Fire Protection Association; 2006.
- C. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- D. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.; 2003.

- E. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc.; 1999.
- F. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.; 1999.

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 combination fire 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.
2. Titus.
3. Greenheck.

- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.2 ACOUSTICAL AIR TURNING DEVICES

A. Manufacturers:

1. Ductmate.

- B. Acoustical turning vane, 4" double wall with 1.3# insulation fill and perforated facing.

2.3 BACKDRAFT DAMPERS

A. Manufacturers:

1. Ruskin Company.
2. Greenheck.

- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) 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. Dampers shall be ultra-low-leakage and heavy duty.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Ruskin Company.
2. Greenheck.

- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

- C. Provide factory sleeve and collar for each damper.

- D. Ratings:

1. Fire Resistance: 1-1/2 hours in accordance with UL555.
2. Smoke Rating:
FSD37 – Leakage Class I Smoke Damper in accordance with UL555S. A Class I smoke damper leaks no more than 8 cubic feet per minute (.23 m³/min) at 4 in. wg. (1 kPa.) differential pressure.
3. Elevated Temperature Rating: 250°
4. Air Flow Rating: 2000 fpm.
5. Differential Pressure Rating: 4 in. wg.

E. Construction:

1. Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel type frame.
2. Blades:
 - a. Style: Single skin with 3 longitudinal grooves.
 - b. Action: Opposed.
 - c. Material: Minimum 16 gage (1.6 mm) galvanized steel.
 - d. Width: Maximum 6 inches (152 mm).
3. Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.
4. Seals:
 - a. Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450°F (232°C) and galvanized steel for flame seal to 1,900°F (1,038°C). Mechanically attached to blade edge (glue-on or grip type seals are not acceptable).
 - b. Jamb: Stainless steel, flexible metal compression type.
5. Linkage: Concealed in frame.
6. Axles: Minimum ½ inch (13) diameter plated steel, hex-shaped, mechanically attached to blade.
7. Mounting: Vertical and/or Horizontal.
8. Temperature Release Device: Heat-Actuated, Quick Detect.
 - a. Close (in a controlled manner) and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades.
 - b. Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.
 - c. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
9. Release Temperature: 165 degrees F (74 degrees C).
10. Actuator:
 - a. Type: Electric 120 V, 60 Hz, two-position, fail close.
 - b. Mounting: External.
11. Finish: Mill galvanized.

F. ACCESSORIES

1. Mounting Angles
2. Factory Sleeve
3. Breakaway Connections

2.5 DUCT ACCESS DOORS

A. Manufacturers:

1. Ruskin Company.
2. Greenheck.
3. Approved Equal.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Access doors with sheet metal screw fasteners are not acceptable.

2.6 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.

2.7 FIRE DAMPERS

A. Manufacturers:

1. Ruskin Company.
2. Greenheck.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling Dampers: Galvanized steel, 22 gage (0.76 mm) frame and 16 gage (1.5 mm) flap, two layers 0.125 inch (3.2 mm) ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.

D. Horizontal Dampers: Galvanized steel, 22 gage (0.76 mm) 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 (250 Pa) pressure class ducts up to 12 inches (300 mm) in height.

- F. Multiple Blade Dampers: 16 gage (1.5 mm) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch (3.2 x 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- G. Fusible Links: UL 33, separate at 165 degrees F.
- H. All dampers shall be dynamic type.

2.8 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 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 (1.0 kg/sq m).

2.9 SMOKE DAMPERS

- A. Manufacturers:
 - 1. Ruskin Company.
 - 2. Greenheck.
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Ratings:
 - 1. Smoke Rating: Leakage Class I Smoke Damper in accordance with UL555S. A Class I smoke damper leaks no more than 8 cubic feet per minute (.23 m³/min) at 4 in. wg. (1 kPa.) differential pressure.
 - 2. Elevated Temperature Rating: 250 F
 - 3. Air Flow Rating: 2000 fpm.
 - 4. Pressure Rating: 4 in. wg.
- D. Construction:
 - 1. Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel type frame.
 - 2. Blades:
 - a. Style: Single skin with 3 longitudinal grooves or true airfoil-shaped, single piece, double skin (manufacturers choice).
 - b. Action: Opposed.

- c. Orientation: Horizontal.
- d. Material: Minimum 16 gage (1.6 mm) galvanized steel.
- e. Width: Maximum 6 inches (152 mm).
3. Bearings: Self-lubricating stainless steel sleeve, turning in extruded hole in frame.
4. Seals:
 - a. Blade: Inflatable silicone material to maintain smoke leakage rating to a minimum of 450°F (232°C). Mechanically attached to blade edge (glue-on or grip type seals are not acceptable).
 - b. Jamb: Stainless steel, flexible metal compression type.
5. Linkage: Concealed in frame.
6. Axles: Minimum ½ inch (13) diameter plated steel, hex-shaped, mechanically attached to blade.
7. Mounting: Vertical and/or Horizontal.
8. Actuator: Electric 120V, 60 Hz, two position, fail close, external mount.
9. Finish: Mill galvanized.

E. Accessories

1. Factory Sleeve:
 - a. Minimum 20 gage (1.0 mm) thickness.
 - b. Minimum 12 inches (432 mm) long.

2.10 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Ruskin Company.
2. Greenheck.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Splitter Dampers:

1. Material: Same gage as duct to 24 inches (600 mm) size in either direction, and two gages heavier for sizes over 24 inches (600 mm).
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch (6 mm) 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 (150 x 760 mm).

E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch (200 x 1825 mm). 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 (300 mm) 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.
 - 3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.

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 - Metal and Flexible. Refer to Section 23 3100 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 for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated. Provide 4 x 4 inch (100 x 100 mm) 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, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install smoke dampers and combination smoke and fire dampers in accordance with

NFPA 92A.

- G. Demonstrate re-setting of fire dampers to School District's representative.
- H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- J. 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.
- K. Use splitter dampers only where indicated.
- L. Provide balancing dampers on high velocity systems where indicated. Refer to Section 23 3600 - Air Terminal Units.
- M. 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.
- N. 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

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 233416 – CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof exhaust fans.

1.2 RELATED SECTIONS

- A. Section 23 0714 – HVAC Duct Insulation.
- B. Section 23 3300 - Air Duct Accessories.
- C. Section 23 0549 - Vibration Isolation.
- D. 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. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (R2000).
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; American Bearing Manufacturers Association, Inc.; 1990 (R1999).
- C. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 2003.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 1999 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- E. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; <http://www.amca.org/licenses/search.aspx>.
- F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2005.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 2005.
- H. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet

Metal and Air Conditioning Contractors' National Association; 2005.

1.4 PERFORMANCE REQUIREMENTS

- A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. Fabrication: Conform to AMCA 99.
- D. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

1.5 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Include complete installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

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.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

1.9 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Supply two sets of belts for each fan.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Loren Cook Company: www.lorencook.com.
- B. Greenheck: www.greenheck.com
- C. Pre-Approved Equal.

2.2 ROOF EXHAUST FANS

- A. General Description:
 - 1. Fan shall be downblast type and shall be for roof mounted applications
 - 2. Maximum continuous operating temperature shall be a minimum of 180 Fahrenheit (82.2 Celsius)
 - 3. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.
- B. Wheel:
 - 1. Constructed of aluminum
 - 2. Non-overloading, backward inclined centrifugal
 - 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
 - 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- C. Motors:
 - 1. Electronically Commutated Motor
 - a. Motor enclosure: ODP
 - b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable.
 - c. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
 - d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal
 - f. Motor shall be a minimum of 85% efficient at all speeds

- D. Housing:
 - 1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
 - 2. Shroud shall have an integral rolled bead for extra strength
 - 3. Shroud shall be drawn from a disc and direct air downward
 - 4. Lower windband shall have a formed edge for added strength
 - 5. Motor cover shall be drawn from a disc
 - 6. All housing components shall have final thicknesses equal to or greater than preformed thickness
 - 7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
 - 8. Rigid internal support structure
 - 9. Leak proof

- E. Housing Supports and Drive Frame:
 - 1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

- F. Vibration Isolation:
 - 1. Rubber isolators
 - 2. Sized to match the weight of each fan

- G. Disconnect Switches:
 - 1. NEMA rated: NEMA 1: indoor application no water. Factory standard.
 - 2. Positive electrical shut-off
 - 3. Wired from fan motor to junction box installed within motor compartment

- H. Accessories:
 - 1. Birdscreen:
 - a. Material Type: Galvanized
 - b. Protects fan discharge
 - 2. Roof Curbs:
 - a. Welded, straight sided curb with 2 inches of flashing flange and wood nailer
 - b. Material: Galvanized
 - c. Height: 18"
 - d. Insulation thickness: 1.5 inches
 - 3. Dampers:
 - a. Gravity backdraft damper
 - 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 prepunched mounting holes

PART 3 EXECUTION

3.1 INSTALLATION

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

- B. Install flexible connections between fan inlet and discharge ductwork; refer to Section 23 3300. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
- C. Provide safety screen where inlet or outlet is exposed.
- D. Provide backdraft dampers on discharge of exhaust fans and as indicated; refer to Section 23 3300.
- E. Contractor shall coordinate installation of roof curb with roofing manufacturer and installer.

3.2 START-UP

- A. Provide initial start up and shut down during first year of operation, including routine servicing in accordance with the manufacturer's recommendations.

END OF SECTION 233416

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 233600 – AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable air volume terminal units.
- B. Fan-powered variable air volume terminal units.
- C. Integral heating coils.

1.2 RELATED SECTIONS

- A. Section 23 3100 - HVAC Ducts and Casings.
- B. Section 23 3300 - Air Duct Accessories.
- C. Section 23 3700 - Air Outlets and Inlets.
- D. 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. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems; National Fire Protection Association; 2002.
- B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; 2005.
- C. VOC content of adhesives and sealants shall be less than SCAQMD Rule #1168 and must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

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 which 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.
- 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.
- H. Adhesives: Provide data for each intended application from the manufacturer of adhesives indicating the volatile organic compound (VOC) content, as measured in grams/liter.
- I. Sealants: Provide data for each intended application from the manufacturer of sealants indicating the volatile organic compound (VOC) content, as measured in grams/liter.

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 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.
- B. Provide five-year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Johnson Controls, Inc.
- B. Daikin.
- C. Trane.

2.2 MANUFACTURED UNITS

- A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electric 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 (0.8 mm) galvanized steel.
- 2. Lining: Minimum 1 inch (25 mm) thick neoprene or vinyl coated fibrous glass insulation with foil face, 1.5 lb/cu ft (24 g/L) density, meeting NFPA 90A requirements and UL 181 erosion requirements.
- 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 (0.25 kPa) rated inlet static pressure.

C. Electric Heating Coil:

- 1. Coil shall be factory provided and mounted resistance open-type heater with airflow switch, a disc-type automatic pilot duty thermal primary cutoff, and manual reset load carrying thermal secondary device. Heat element material shall be nickel-chromium.
- 2. Factory shall install and wire power line fusing, disconnect switch, and 24V transformer.
- 3. Provide factory mounting and wiring of controls. Controls shall be provided by ATC Contractor. Refer to section 230923.

2.4 SERIES FAN-POWERED VAV BOX

A. Basic Assembly:

- 1. Casings: Minimum 22 gage (0.8 mm) galvanized steel.
- 2. Lining: Minimum 1 inch (25 mm) thick neoprene or vinyl coated fibrous glass

insulation with foil face, 1.5 lb/cu ft (24 g/L) density, meeting NFPA 90A requirements and UL 181 erosion requirements.

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 (0.25 kPa) rated inlet static pressure.

C. Electric Heating Coil:

1. Coil shall be factory provided and mounted resistance open-type heater with airflow switch, a disc-type automatic pilot duty thermal primary cutoff, and manual reset load carrying thermal secondary device. Heat element material shall be nickel-chromium.
2. Factory shall install and wire power line fusing, disconnect switch, and 24V transformer.
3. Provide factory mounting and wiring of controls. Controls shall be provided by ATC Contractor. Refer to section 230923.

D. Motor and Fan Assembly:

1. The unit fan shall utilize a forward curved, dynamically balanced, galvanized wheel with a direct drive motor.
2. Fan motor shall be Electronically Commutated Motor (ECM) motor type.
3. Motor shall be brushless DC controlled by an integral controller / inverter that operates the wound stator and senses rotor position to electronically commutate the stator.
4. Motor shall be permanent magnet type with near-zero rotor losses designed for synchronous rotation.
5. The motor shall utilize permanently lubricated ball bearings.

E. Filters:

1. Terminals shall include a 1" thick disposable fiberglass filter. Filter shall be secured with quick release clips, allowing removal without horizontal sliding.

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 3100.
- D. Provide minimum of 5 ft (1.5 m) of 1 inch (25 mm) thick lined ductwork downstream of units.

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. Set units with heating coils for minimum 30 percent full flow.

END OF SECTION 233600

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 233700 – AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/grilles.

1.2 REFERENCES

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 1999.
- B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute; 2001.
- 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.; 1991.
- D. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

1.3 SUBMITTALS

- A. See Division 1 - Administrative Requirements for submittal procedures.
- B. 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.
- C. Samples: Submit one of each required air outlet and inlet type.
- D. 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. Kreuger.
- B. Price.
- C. Titus.
- D. Metalaire

2.2 RECTANGULAR CEILING DIFFUSERS

- A. Description: A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. Steel or aluminum induction blades shall be welded to each wing of the inner core. The induction blades shall be oriented at 45° angles in opposite directions to ensure rapid mixing of primary and room air. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.
- B. Frame: Surface mount type. In ACT, where outer dimensions are 18x18 or greater, lay-in type shall be used.
- C. Color: As shown on drawings.
- D. Damper: Optional damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the diffuser by removing the spring loaded inner core assembly.

2.3 PERFORATED FACE CEILING DIFFUSERS

- A. Description: Diffusers shall have a perforated face with 3/16-inch diameter holes on 1/4-inch staggered centers and no less than 51 percent free area. Perforated face shall be steel or aluminum. The backpan shall be one piece stamped heavy gauge steel of the sizes and mounting types shown on the plans and outlet schedule. The diffuser neck

shall have 1 1/8-inch depth for easy duct connection. Diffusers must discharge a uniform horizontal blanket of air into the room and protect ceiling against smudging. Pattern controllers in the supply models shall be mounted on the back of the perforated face and must be field adjustable to allow the discharged air to enter the room in either vertical or one-, two-, three- or four-way horizontal jets. The perforated face must be easily unlatchable from the backpan to facilitate option of the face for pattern controller adjustment or to access an optional damper. The return models shall have the same face and border construction as the supply models for harmonious appearance in the room.

- B. Frame: Lay-in type.
- C. Color: As shown on drawings.
- D. Damper: Optional damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the diffuser by unlatching the diffuser face. The diffuser must be designed such that complete removal of the face is not required during damper adjustment.

2.4 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Description: Grilles shall have 3/4-inch blade spacing. The fixed deflection blades shall be available parallel to the long or short dimension of the grille. Construction shall be of extruded steel or aluminum with a 1¼-inch wide border on all sides. Minimum border thickness shall be 0.040-0.050 inch. Sizes 24 x 24 inches and smaller shall be constructed using a roll-formed frame. Corners shall be welded with full penetration resistance welds. Sizes larger than 24 x 24 inches shall be constructed by using heavy steel or aluminum extrusions and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be counter-sunk for a neat appearance. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed in place by crimping or welding. Blade deflection angle shall be available at 35°.
- B. Frame: Surface mounted with countersunk screw mounting. In ACT, where nominal dimensions are 18x18 or greater, lay-in type shall be used.
- C. Color: As shown on drawings.
- D. Damper: Optional opposed blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the grille.

2.5 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Supply grilles shall be double deflection. The deflection blades shall be available parallel to the long dimension of the grille or register. Construction shall be of steel or aluminum with a 1¼-inch wide border on all sides. Sizes 24 x 24 inches and below shall have roll-formed borders with a minimum thickness of 0.032 inch. Larger sizes shall be

constructed using continuous steel or aluminum extrusions with a nominal thickness of 0.040 through 0.050 inch and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be countersunk for a neat appearance. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be spaced on 3/4-inch centers. Blades shall have friction pivots on both sides to allow individual blade adjustment without loosening or rattling or be inserted through the frame and held tight with steel friction wire interlocked to the frame on both ends of each side. Plastic blade pivots are not acceptable.

- B. Frame: Surface mounted with countersunk screw mounting.
- C. Damper: Optional opposed blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the grille.

2.6 LINEAR SLOT DIFFUSERS

- A. Fabrication: Linear slot diffusers shall have slot spacing of the sizes and mounting types shown on the plans. Linear slot diffusers shall be available in standard one piece lengths up to 6 feet and 1 to 8 discharge slots. Diffuser lengths greater than 6 feet shall be furnished in multiple sections and will be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components to be provided by the manufacturer.
- B. Frame: The frame and support bars shall be constructed of heavy gauge extruded aluminum. The pattern controller shall be an aerodynamically curved "ice-tong" shaped steel deflector capable of 180° pattern adjustment from the face of the diffuser and shall allow dampening if required. Maximum pattern controller length shall be 3 feet, for diffusers longer than 3 feet pattern controllers shall be furnished in multiple sections. Surface mount type with countersunk screw mounting for hard ceilings or lay-in mount type for ACT.
- C. Color: The face finish shall be as shown on the drawings and the pattern colors shall have a black finish.
- D. Accessories: Heavy gauge extruded aluminum end borders, end caps and mitered corners shall be available to close off the ends of the diffusers. Plenums shall be manufactured by the same manufacturer of the linear slot diffusers.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to

conform with architectural features, symmetry, and lighting arrangement.

- C. Install diffusers to ductwork with air tight connection.
- D. 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.
- E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9000.

END OF SECTION 233700

THIS PAGE INTENTIONALLY LEFT BLANK

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

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 237302 - ROOFTOP AIR HANDLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outdoor air handling units and components as scheduled and shown on drawings.

1.2 RELATED SECTIONS

- A. The requirements of the General Conditions, Supplementary Conditions, Division 1, equipment schedules, and drawings apply.
- B. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- C. Section 23 3300 - Air Duct Accessories: Flexible duct connections.
- D. Section 23 0923 – Automatic Temperature Controls.
- E. Section 23 0993 – HVAC Controls Sequence.

1.3 REFERENCES

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2000).
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 1999).
- C. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 2003.
- D. 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).
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 2006.

- G. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2007.
 - H. ARI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; Air Conditioning and Refrigeration Institute; 2001 (R2005) .
 - I. ARI 430 - Standard for Central-Station Air-Handling Units; Air-Conditioning and Refrigeration Institute; 2009.
 - J. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.
 - K. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.
 - L. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
 - M. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.
 - N. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.; 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.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten 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 PROTECTION

- 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.

1.8 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Supply two set for each unit of filters.
- C. Provide additional fan sheave and drive package for each fan for the immediate size above and below factory recommended drive.

1.9 WARRANTIES

- A. The unit shall be warranted by the manufacturer against defects in material and factory workmanship for one year. A minimum (5) five-year compressor warranty shall be provided. First year of warranty shall include parts and labor. The warranties shall begin when the building has been determined to be substantially complete.

1.10 MAINTENANCE SERVICE

- A. Furnish service and maintenance of complete assembly for one year from Date of Substantial Completion.
- B. All inspections and service of units shall be accomplished by unit manufacturers factory trained and authorized servicing technicians.
- C. The manufacturer shall provide and report quarterly, annual and bi-annual maintenance in compliance with or better than ASHRAE Standard 180-2008.
- D. Include maintenance items as recommended in manufacturer's operating and maintenance data.
- E. Submit copy of service call work orders and summary report to the Owner, including description of work performed, operating performance status and noted exceptions.

1.11 SYSTEM STARTUP

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test-run under observation.
- B. Comply with manufacturer's start-up requirements to ensure safe and correct operation and integrity of warranty.

PART 2 PRODUCTS

2.1 ACCEPTABLE PRODUCTS

- A. Johnson Controls, Inc.
- B. Trane.
- C. Daikin.

2.2 General Unit Description

- A. Packaged rooftop units cooling, heating capacities, and efficiencies are AHRI Certified within scope of AHRI Standard 210-240 for 6 to 25 Tons and ANSIZ21.47 and 10 CFR Part 431 pertaining to Commercial Warm Air Furnaces (all gas heating units).
- B. Rooftop unit shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory.
- C. All units, 3-25T shall have field convertible airflow.

- D. Internal wiring must be colored and numbered for simplified identification.
- E. Symbio controls operating range shall be between 0°F and 125°F in cooling mode.

2.3 UNIT CASING

- A. Cabinet: Galvanized steel with baked enamel finish.
- B. Rooftop unit casing shall be zinc coated, heavy gauge, steel. Casing panels are weather resistant pre-painted metal with galvanized substrate and meet ASTM B117, 672 hour salt spray test.
- C. Cabinet top cover shall be one piece construction or where seams exits, it shall be double-hemmed and gasket-sealed.
- D. Unit shall include a removable single side maintenance access panels. Lifting handles in maintenance access panels can be removed and reinstalled by removing fasteners while providing a water and air tight seal.
- E. Unit's base pan shall have a raised 1 1/8 inch high lip around the supply and return openings for water integrity.
- F. Exposed vertical panels and top covers in the indoor air section are insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material.
- G. Base pan shall have no penetrations within the perimeter of the curb other than the raised 1 inch high downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up.
- H. Base of the unit is insulated with 1/8 inch, foil-faced, closed-cell insulation.
- I. Provide openings either on side of unit or through the base for power, control, condensate, and gas connections.
- J. Unit base shall contain provisions for forklift and/or crane lifting on three sides of unit.

2.4 AIR FILTERS

- A. 2-inch MERV 8 and MERV 13 filters.

2.5 FANS AND MOTORS

- A. Supply fan shall be a direct drive plenum fan with backward-curved fan wheel with an external rotor direct drive variable speed motor.
- B. Supply fan speed adjustments can be made using the control user interface or mobile app.

- C. Provide Fan Fail indication. The indication will be registered at the on-board user interface, mobile service app., or building management system.
- D. Variable speed direct drive motors are premium efficiency – 6 to 25 tons.
- E. Motors are thermally protected.
- F. Outdoor fans shall be direct drive, statically and dynamically balanced, draw through in the vertical discharge position. Outdoor motors shall be 3 phase.
- G. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

2.6 ELECTRIC HEATING SECTION

- A. Provide heavy duty nickel chromium heating elements internally Delta connected for 240V, wye connection for 480V and 600V. Each heater package shall have automatically reset high limit control operating through heating element contactors. Backup protection is also provided via non-resettable single operation limits connected directly to high voltage. All heaters shall be individually fused from the factory, where required, and shall meet all NEC and CEC requirements when properly installed. Power assemblies shall provide single point connection. Electrical heat modules shall be cULus listed.
- B. Heater shall be internal to unit cabinet.
- C. Heater shall be UL and CSA listed and approved and provide single point power connection.

2.7 EVAPORATOR COIL

- A. Aluminum Microchannel coils shall provide optimal heat transfer performance due to flat, streamlined tubes with small ports, and metallurgical tube-to-fin bond
- B. Provide a removable, reversible, cleanable double sloped drain pan for base of evaporator coil constructed of PVC.
- C. Unit shall include a condensate overflow switch to shut the unit down in the event that a clogged condensate drain line prevents proper condensate removal from the unit.

2.8 CONDENSER SECTION

- A. Provide vertical discharge, direct drive fans with aluminum blades. Fans shall be statically balanced. Motors shall be permanently lubricated, with integral thermal overload protection in a weather tight casing.
- B. Microchannel condenser to be standard on all units.

- C. Provide tool-less factory installed corrosion resistant louvered hail/vandalism guards to protect condenser coils from hail or physical damage.

2.9 REFRIGERATION SYSTEM

- A. All units have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Suction gas-cooled motor with voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads standard with scroll compressors. Crankcase heaters are standard on all compressors.
- B. Compressors shall have thermostatic temperature motor winding control for protection against excessive temperatures caused by over/under voltage operation or loss of charge. Also provide high and low pressure switches.
- C. Thermal Expansion valves are standard for all models.
- D. All units have dual compressors.
- E. Units shall have cooling capabilities down to 0 degree F as standard. For field-installed low ambient accessory, the manufacturer shall provide a factory-authorized service technician that will assure proper installation and operation.
- F. Three stages of cooling available on 6 to 17.5 tons units and four stages of cooling available on 20 and 25 ton units.

2.10 EXHAUST/RETURN SECTION

- A. Provide barometric relief gravity type dampers to operate in conjunction with economizer to provide exhaust and maintain space pressurization.

2.11 OUTDOOR AIR SECTION

- A. Units shall be available with barometric relief.
- B. Barometric relief shall provide a pressure operated damper that shall be gravity closing.
- C. Barometric relief shall prohibit entrance of outside air during the equipment "off" cycle.
- D. Motorized outside air damper, once set, when indoor fan starts, outdoor air dampers shall open to set position. When indoor fan shuts down, damper shall close to the full closed position.
- E. Provide spring return motor for outside air damper closure during unit shut down or power interruption.
- F. Provide microprocessor unit-mounted control which when used with an electronic zone sensor provides proportional integral room control. This UCM shall perform all unit functions by making all heating, cooling and ventilating decisions through resident software logic.

- G. Provide factory-installed indoor evaporator defrost control to prevent compressor slugging by interrupting compressor operation.
- H. Provide an anti-cycle timing and minimum on/off between stages timing in the microprocessor.

2.12 SYSTEM CONTROL

- A. SZ VAV: Provide all necessary controls to operate a rooftop unit based on maintaining two temperature setpoints: discharge air and zone. During one zone vav cooling, the unit will maintain zone cooling setpoint by modulating the supply fan speed more or less to meet zone load demand; and the unit will maintain discharge temperature to the discharge cooling setpoint by modulating economizer if available and staging dx cooling.

2.13 ROOF CURB

- A. Contractor shall provide factory supplied roof curb, 16 gauge perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship knocked down and provided with instructions for easy assembly.
- B. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

2.10 CONTROLS

- A. Provide unit ready for field mounting and wiring of controls by others. Controls shall be provided by ATC Contractor. Refer to section 230923.

PART 3 EXECUTION

3.1 SHIPPING

- A. Paper copies of the IOM shall also be shipped with each RTU.
- B. The RTU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the RTU manufacturer shall place them in containers.
- C. To protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment
- D. After loading the equipment for shipment, the RTU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.2 ON-SITE STORAGE

- A. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.3 FIELD EXAMINATION

- A. The Mechanical Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
- B. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.

3.4 INSTALLATION

- A. The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Owner and the Owner's selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.
- B. The RTU manufacturer shall provide all screws and gaskets for joining of sections in the field.
- C. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the RTU manufacturer's final inspection and start up:
 - 1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
 - 2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
 - 3. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
 - 4. All power wiring, including motor starters and disconnects, serving the unit has been completed.
 - 5. All automatic temperature and safety controls have been completed.
 - 6. All dampers are fully operational.
 - 7. All shipping materials have been removed.
 - 8. All (clean) filter media has been installed in the units.

3.5 LEVELING

- A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

3.6 FINAL INSPECTION AND START UP SERVICE

- A. After the Mechanical Contractor has provided all water and steam piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor shall then perform startup of the equipment.
- B. The Automatic Temperature Control (Building Direct Digital Control) Contractor shall be scheduled to be at the job site at the time of the equipment start up.
- C. The Mechanical Contractor, shall perform the following tests and services and submit a report outlining the results:
 - 1. Record date, time, and person(s) performing service.
 - 2. Lubricate all moving parts.
 - 3. Check all motor and starter power lugs and tighten as required.
 - 4. Verify all electrical power connections.
 - 5. Conduct a start up inspection per the AHU manufacturer's recommendations.
 - 6. Record fan motor voltage and amperage readings.
 - 7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
 - 8. Check fan for excessive vibration.
 - 9. Check V belt drive or coupling for proper alignment.
 - 10. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
 - 11. Disengage all shipping fasteners on vibration isolation equipment.
 - 12. Check safety guards to insure they are properly secured.
 - 13. Secure all access doors to the fan, the unit and the ductwork.
 - 14. Switch electrical supply "on" and allow fan to reach full speed.
 - 15. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.
 - 16. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.
 - 17. Check all control sequences.

END OF SECTION 237302

SECTION 238101 – TERMINAL HEAT TRANSFER UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cabinet unit heaters.

1.2 RELATED SECTIONS

- A. Section 23 0993 - HVAC Control Sequence.
- B. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Summary of the Project.

1.3 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. 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.,
- D. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- E. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- F. Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- G. 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.
- B. Provide one year manufacturer's warranty for all equipment specified herein. The warranties shall begin when the building has been determined to be substantially complete.

1.6 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Provide two sets of filters.

PART 2 PRODUCTS

2.1 ELECTRIC CABINET HEATERS

- A. Manufacturers:
 - 1. Berko.
 - 2. Qmark.
 - 3. Markel.
- B. General: Heaters shall be UL listed, designed for mounting in any position, including on-end, fully recessed, semi-recessed or surface mounted. All three phase heaters shall have a balanced heating load. Control voltage is to be internally generated by 24 VAC.
- C. Cabinet: The cabinet shall be of heavy duty cold-rolled steel. The heater front covers shall be securely attached to the cabinet with a maximum of two slotted head style spring latches and easily removable for access to elements, filters and control panel. Cabinet shall be finished with a polyester powder coated in a color selected from the manufacturer's standard color chart.
- D. Motor: The motor(s) and blower(s) shall be direct drive and resiliently mounted on a rigid heavy duty frame for quiet operation and long life. The motor(s) shall be two speed with automatic reset overload protection. The motor shall be vented and mounted in the air stream to provide maximum cooling of the motor(s). Motor(s) fuse protection shall be provided to meet UL, cUL and NEC requirements. The blower(s) shall be forward

curved, double inlet, centrifugal type with discharge directly on the full length of the elements to provide uniform discharge air temperatures.

- E. Heating element: The heating elements shall be warranted for five years and shall be of non-glowing design consisting of 80/20 NiChi resistance wire enclosed in a steel sheath to which steel plate fins are brazed. The heating element shall be located directly in front of the blower discharge air for uniform heating.
- F. Safety Thermal Cutouts: Thermal safety cutouts shall be built into the system to automatically shut off heater in event of overheating due to any cause. The safety cutouts shall directly interrupt power to the elements and not depend on relays to interrupt the power.
- G. Filters: The filter shall be located ahead of the motor and blower assembly to ensure clean air circulation. Filter shall be easily removed for changing or cleaning by removing the front panel and pulling on the filter. A permanent washable filter shall be provided.
- H. Front Cover Interlock: Heater shall be provided with an electrical interlock to shut down the heater when the front cover is opened to provide safety to the maintenance personnel during filter cleaning (replacement) or other maintenance.
- I. Fan Delay Control: Fan control shall delay start up of the fan motor(s) until the heating elements have warmed up. It shall maintain motor operation after heating elements have been de-energized to dissipate residual heat.
- J. Temperature Control: Thermostat shall be built-in, snap-action single stage with remote bulb sensor located in the return air stream. (Optional - built-in two stage remote bulb snap action thermostat, remote mounted single stage wall thermostat, remote mounted two stage wall thermostat) Terminals shall be provided in the control panel for direct connection of the remote wall mounted thermostats. Silent time delay relays shall be provided, rather than contactors, to eliminate the noise of contactor opening and closing.
- K. Terminals for Remote Interlock: Terminals shall be provided in the control panel for connection to Building Automation or Energy Management Systems.
- L. Accessories: Provide a recess trim kit if cabinet heater is scheduled to be partially or fully recessed. Provide a base kit if cabinet heater is scheduled to be floor mounted.

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. 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.

3.3 START-UP

- A. The contractor shall submit to the Owner, a fully completed start-up and field test report for each unit. The test report shall be per manufacturer's standard format and list all test conditions, settings, and performance data.

END OF SECTION 238101

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 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2013 (ANSI/ASHRAE Std 15).
- D. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.
- E. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2013, Including All Addenda (ANSI/ASHRAE/IES Std 90.1).
- F. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.

- I. 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.

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.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience and approved by manufacturer.

1.5 WARRANTY

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fujitsu

- B. Mitsubishi.
- C. Sanyo.

2.2 SYSTEM DESIGN

- A. Split-System Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating: None.
 - 2. Cooling: Outdoor electric condensing unit with evaporator in indoor ductless unit.
 - 3. 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.
 - 1. Fan: Line-flow fan direct driven by a single motor.
- 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 207.
 - 2. Manufacturer: System manufacturer.

2.4 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Air Cooled Condenser: ARI 520; Aluminum fin and copper tube coil, with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
- C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
- 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.
 - 3. Provide wind baffle for low ambient cooling.

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 NFPA 90A and NFPA 90B.
- B. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION 238127

SECTION 260100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary 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. Rework existing Electrical service
 - 2. New Lighting and Lighting Controls.
 - 3. New outdoor emergency generator and associated transfer switches.
 - 4. New Fire Alarm and Detection system with new addressable, horn alarm system.
 - 5. New structured cabling system with Cat 6A plenum-rated UTP wiring.
 - 6. New PA/Intercom system with a new IP system.
 - 7. New Wiring, raceways and backboxes for Access Control System.
 - 8. New Security Intrusion System.
 - 9. New local sound systems for board room.
 - 10. Control wiring for Division 23 equipment where shown on Division 26 documents.

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 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, either 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 SPECIAL 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.
 - 1. Metal Clad Cable
 - 2. Building Wire
 - 3. Conduit
 - 4. Fittings
 - 5. Wireways
 - 6. Outlet Boxes

7. Switches
8. Receptacles
9. Dry-type energy-efficient transformers
10. Electronic Circuit Monitors
11. Panelboards and Circuit Breakers
12. Safety Switches and Fuses
13. Fire Alarm & Detection System Equipment
14. Structured Cabling system.
15. Emergency Generator & ATS
16. Interior Lighting
17. Lighting controls
18. PA and Master clock System.

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 expense.

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 the date of substantial completion of the **final phase of the project**. 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

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 Construction Manager and Architect and prepare dated, dimensioned drawings correcting the interferences. Obtain written approval of the Construction Manager and Architect for such changes and distribute the drawings to all interested parties as directed by the Construction Manager and Architect.
- C. In modular panel ceilings, locate lights, detectors and similar equipment as shown on reflected ceiling plan. Arrange ceiling outlets symmetrically. Verify locations of all floor outlets with Architect before roughing-in.
- 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, Grading and Site Work, Section 33, and Earthwork, Division 2.
- 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 Construction Manager or Architect.

3.3 FLASHING AND COUNTERFLASHING:

- A. Provide metal flashing and counterflashing under Division 26 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 SUPPLEMENTAL GENERAL CONDITIONS. Make detailed dimensioned drawings under Division 26 where required by Architect.

3.5 CUTTING AND PATCHING:

- A. Perform all cutting of existing building construction under Division 26 as required for installation of electrical work.
- B. 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. Patch unsightly conditions resulting from cutting as directed by the Construction Manager or Architect. Engage competent mechanics for patching.

3.6 CONCRETE:

- A. Provide all concrete required for the work of Division 26 - ELECTRICAL, unless otherwise noted. Provide 3000 pound concrete in accordance with the provisions of Division- CONCRETE.
- B. Provide concrete housing cleaning pads for all freestanding electrical equipment inside and site light bases outside building, unless otherwise noted. Include all required anchor bolts, fish plates, sleeves, inserts, conduit and miscellaneous hardware and have them installed in their proper location in all concrete foundations.

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 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.	Phase	208/120 Volts	480/277 Volts
2.	Phase "A"	Black	Brown
3.	Phase "B"	Blue	Orange
4.	Phase "C"	Red	Yellow
5.	Neutral	White	Gray
6.	Equipment ground	Green	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 Construction Manager 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 Construction Manager 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.

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 pipe sizing, location, and details. The record set of installation prints shall be updated at the end of each month and shall be delivered to the Construction Manager and the Architect.
- B. At the completion of the work, the Contractor shall forward these prints to the Construction Manager and the Architect for incorporation into the final As-Built Drawings.

3.15 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. The instruction shall be video recorded and a copy of the recording turned over to the Owner for future reference.
- 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/Intercom and Master Clock System
 - 3. Security Detection and Alarm System.
 - 4. Theatrical Lighting and Sound Systems.
 - 5. Local sound systems.
 - 6. Lighting control systems.
 - 7. A/V Systems

END OF SECTION 260100

SECTION 26 0505 - 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.
- B. Section 02 8400 - Polychlorinate Biphenyl (PCB) Remediation: Removal of equipment and materials containing substances regulated under the Federal Toxic Substances Control Act (TSCA), including but not limited to those containing PCBs and mercury.

1.3 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

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 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Telephone System: 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. Notify Owner at least 24 hours before partially or completely disabling system.
 - 2. Notify telephone utility company at least 24 hours before partially or completely disabling system.
 - 3. Make temporary connections to maintain service in areas adjacent to work area.
- F. Existing SLUHN Data System System: 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 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. 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.

- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. 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.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION 260505

THIS PAGE WAS INTENTIONALLY LEFT BLANK

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 078400 - Firestopping.
- B. Section 260513 - Medium-Voltage Cable: Cables and terminations for systems 601 V through 35,000 V.
- C. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 283100 - Fire Detection and Alarm: Fire alarm system conductors and cables.
- E. Section 312316 - Excavation.
- F. 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.
 - 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 contaminates. 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 078400.

- 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. Ground access wells.
- G. 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 260536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 033000 - Cast-in-Place Concrete.
- E. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.3 REFERENCE STANDARDS

- A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; Institute of Electrical and Electronic Engineers; 2012.
- 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 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.
- F. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2014.
- 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 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, locate 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. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.

6. 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.
7. 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 water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. 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.

- K. Cable Tray Systems: Also comply with Section 260536.
- L. Pole-Mounted Luminaires: Also comply with Section 265600.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

- 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
- 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 260526:

- 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. Thomas & Betts Corporation: www.tnb.com.
 - c. Panduit.
 - 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.

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.

F. Ground Access Wells:

1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
 - a. Areas Exposed to Vehicular Traffic: Rated for not less than 20,000 pounds vertical design load.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches in diameter.
 - b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".

2.3 PRODUCTS

- A. Rod Electrodes: Copper.
1. Diameter: 3/4 inch.
 2. Length: 10 feet.
- B. Foundation Electrodes: 3/0 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. 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 7.13.
- 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

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 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 260534 - Conduit: Additional support and attachment requirements for conduits.
- D. Section 260537 - Boxes: Additional support and attachment requirements for boxes.
- E. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- F. Section 265600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.
- G. Conduit and equipment supports.
- H. Anchors and fasteners.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- 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; 2013.
- 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. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
- 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.

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 as suitable for the purpose intended, 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 _____. 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. Materials for Metal Fabricated Supports: Comply with Section 055000.

C. 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 Eaton Corporation: 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. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: 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.

E. 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: Steel sheet, 12 gage, 0.1046 inch.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: 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.

F. 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.

G. 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: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
 - 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 any roof or floor deck. **Provide support from structural steel only.**
- 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. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
 - 5. 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

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260534 - CONDUIT

PART 1 GENERAL

1.1 PROJECT INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Intermediate metal conduit (IMC).
- D. Flexible metal conduit (FMC).
- E. Liquidtight flexible metal conduit (LFMC).
- F. Electrical metallic tubing (EMT).
- G. Rigid polyvinyl chloride (PVC) conduit.
- H. Liquidtight flexible nonmetallic conduit (LFNC).
- I. Conduit fittings.
- J. Accessories.
- K. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 078400 - Firestopping.
- C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
- D. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- E. Section 260529 - Hangers and Supports for Electrical Systems.

- F. Section 260535 - Surface Raceways.
- G. Section 260537 - Boxes.
- H. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- I. Section 262100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.
- J. Section 262701 - Electrical Service Entrance: Additional requirements for electrical service conduits.
- K. Section 271005 - Structured Cabling for Voice and Data - Outside Plant and Inside Plant: Additional requirements for communications systems conduits.
- L. Section 312316 - Excavation.
- M. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.
- N. Section 312323 - Fill: Bedding and backfilling.
- O. Section 337119 - Electrical Underground Ducts and Manholes.

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. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.
- D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2013.
- G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; National Electrical Contractors Association; 2004.

- H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.
- I. 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).
- J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2013.
- K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2015.
- L. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- N. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- O. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- P. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- T. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- U. 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 prior to sweeping up.
 - 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. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Electrical Service Conduits: Also comply with Section 262100.
- C. Communications Systems Conduits: Also comply with Section 271005.
- D. Fittings for Grounding and Bonding: Also comply with Section 260526.

- E. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- F. Provide products listed, classified, and labeled as suitable for the purpose intended.
- G. 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.
- H. 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 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.
4. Under Slab on Grade: Use thinwall nonmetallic conduit. E.C. shall install conduit in stone after placement by the G.C. and before slab pour.
5. Not permitted.

2.6 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.

2.7 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.

2.8 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.
 - b. Do not use set-screw type connectors and couplings.
5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.9 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.

2.10 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.

2.11 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.

- F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits 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 intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.
- H. 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.
- I. 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.
- J. 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. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

K. 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. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. 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.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

L. Underground Installation:

1. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
2. Provide underground warning tape in accordance with Section 260553 along entire conduit length for service entrance where not concrete-encased.

- M. 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.
- N. 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.
- O. 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.
- P. 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.
- Q. Provide grounding and bonding in accordance with Section 260526.
- R. Identify conduits in accordance with Section 260553.

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.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

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 boxes/enclosures.
- E. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 078400 - Firestopping.
- C. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- D. Section 260526 - Grounding and Bonding for Electrical Systems.
- E. Section 260529 - Hangers and Supports for Electrical Systems.
- F. Section 260534 - Conduit:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- G. Section 260535 - Surface Raceways:
 - 1. Accessory boxes designed specifically for surface raceway systems.
 - 2. Lay-in wireways and wiring troughs with removable covers.
- H. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

- I. Section 262726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Poke-through assemblies.
 - 4. Access floor boxes.
 - 5. Additional requirements for locating boxes for wiring devices.

- J. Section 271005 - Structured Cabling for Voice and Data - Outside Plant and Inside Plant:
Additional requirements for communications systems outlet boxes.

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; 2013 (ANSI/NEMA OS 1).

- E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 2013 (ANSI/NEMA OS 2).

- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

- G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- H. SCTE 77 - Specification for Underground Enclosure Integrity; Society of Cable Telecommunications Engineers; 2013 (ANSI/SCTE 77).

- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

- K. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

- L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; 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.
 1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
- 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 as suitable for the purpose intended.
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 cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use suitable concrete type boxes where flush-mounted in concrete.
6. Use suitable masonry type boxes where flush-mounted in masonry walls.
7. Use raised covers suitable for the type of wall construction and device configuration where required.

8. Use shallow boxes where required by the type of wall construction.
 9. Do not use "through-wall" boxes designed for access from both sides of wall.
 10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
 13. 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.
 14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 15. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
 - b. Communications Systems Outlets: 3.5" deep. Comply with Section 271005.
 16. Wall Plates: Comply with Section 262726.
 17. 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. Provide floor boxes to meet the requirements of the project conditions with the number and type of required outlets as indicated on the drawings.
 2. Use cast iron floor boxes within slab on grade.
 3. Use sheet-steel or cast iron floor boxes within slab above grade.

4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
5. Manufacturer: Same as manufacturer of floor box service fittings.

E. Underground Boxes/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 required per NEC or Indicated on Drawings..
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Provide logo on cover to indicate type of service.
5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
 - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 15 load rating.
 - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.

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. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
 - 2. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 3. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 4. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 - 5. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260534.
 - 6. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- 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. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- N. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.
- O. Underground Boxes/Enclosures:
1. Install enclosure on gravel base, minimum 6 inches deep.
 2. Flush-mount enclosures located in concrete or paved areas.
 3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
 4. Provide cast-in-place concrete collar constructed in accordance with Section 033000, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
 5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- P. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- R. Close unused box openings.
- S. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

T. Provide grounding and bonding in accordance with Section 260526.

U. Identify boxes in accordance with Section 260553.

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

THIS PAGE INTENTIONALLY LEFT BLANK

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 - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- C. Section 271005 - Structured Cabling for Voice and Data - Outside Plant and Inside Plant: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- 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. NFPA 70E - Standard for Electrical Safety in the Workplace; National Fire Protection Association; 2015.

- E. 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. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. 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, phase and amperes.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Panelboards:
 - 1) Identify voltage phase and amperes.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify load(s) served. Include location when not within sight of equipment.
 - d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage phase and amperes.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - e. 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.
- f. Transfer Switches:
 - 1) Identify voltage phase and amperes.
 - 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. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
 - c. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.
3. 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.
4. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
5. 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.
6. 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.
7. 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".
8. 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".

9. 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.

C. 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 wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
5. Use underground warning tape to identify direct buried cables *and conduits*.

D. Identification for Boxes:

1. Use voltage markers to identify highest voltage present.
2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.

E. 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.
4. Use identification label to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas, provide identification on inside surface of wallplate.
5. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

F. Identification for Luminaires:

1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

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.
 - d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
 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 Receptacle Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Power source and circuit number or other designation indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Black text on clear background.
- G. 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.
- H. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

I. Locations:

1. Each electrical distribution and control equipment enclosure.
2. Communication cabinets.

J. 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.

L. Wire Markers

1. Manufacturers:
2. Brady Corporation; www.bradyid.com.
3. HellermannTyton; www.hellermanntyton.com.
4. Panduit Corp: www.panduit.com.
 - a. Substitutions: See Section 016000 - Product Requirements.

M. 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.

N. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

O. Legend: Power source and circuit number or other designation indicated.

P. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

1. Do not use handwritten text.

Q. Minimum Text Height: 1/8 inch.

R. Color: Black text on white background unless otherwise indicated.

2.3 VOLTAGE MARKERS

A. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

B. Minimum Size:

1. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
2. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

C. Legend:

1. Markers for Voltage Identification: Highest voltage present.

2.4 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Brady Corporation; www.bradyid.com.
2. Brimar Industries, Inc: www.brimar.com.
3. Seton Identification Products; 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. Boxes: Outside face of cover.
 8. Conductors and Cables: Legible from the point of access.
 9. 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

THIS PAGE INTENTIONALLY LEFT BLANK

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.
 - 1. Includes arc flash hazard warning labels.
- 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 262100 - Low-Voltage Electrical Service Entrance.
- C. Section 262413 - Switchboards.
- D. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- 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 - Includes 1584, 1584A and 1584B; 2002 (Amended 2011).
- G. NEMA MG 1 - Motors and Generators; 2017.
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
- I. NFPA 70 - National Electrical Code; 2017.
- J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Existing Installations: Provide labor for investigation to obtain information and 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 the 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.
3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

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. Study reports, stamped or sealed and signed by study preparer.
- D. 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 busway.
 - 3. Include impedance data for engine generators.
 - 4. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 - 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.
- E. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.
- F. Field quality control reports.
- G. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
- H. 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 or equipment manufacturer's representative 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 achieve full selective coordination while providing adequate protection for equipment and conductors.

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.
 - a. To clarify IEEE 1584 statement that "equipment below 240 V need not be considered unless it involves at least one 125 kVA or larger low-impedance transformer in its immediate power supply" for purposes of studies, study preparer to include equipment rated less than 240 V fed by transformers less than 125 kVA in calculations.
 - b. For single-phase systems, study preparer to perform calculations assuming three-phase system in accordance with IEEE 1584, yielding conservative results.
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 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. Identify locations where the calculated maximum incident energy exceeds 40 calories per sq cm.
 - d. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 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 the preparation of studies of similar type and complexity using specified computer software.
 1. Study preparer may be employed by the manufacturer of the 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.
- C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
 1. Acceptable Software Products:
 - a. EasyPower LLC: www.easypower.com.
 - b. ETAP/Operation Technology, Inc: www.etap.com.

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" where calculated incident energy is less than 40 calories per square cm.

- b. Include red header that reads "DANGER" where calculated incident energy is 40 calories per square cm or greater.
- c. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
- d. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Nominal system voltage.
 - 4) Limited approach boundary.
 - 5) Restricted approach boundary.
 - 6) Equipment identification.
 - 7) 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.

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 260918 - Remote Control Switching Devices: Remotely controlled devices for lighting control, including networked lighting controls, programmable relay panels, and remote control switching relays.
- E. Section 260919 - Enclosed Contactors: Lighting contactors.
- F. Section 262726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, fan speed controllers, and wall plates.
- G. Section 265100 - Interior Lighting.
- I. Section 265600 - Exterior 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 manufacturers 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. Same as Lighting Control System Manufacturer. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval a minimum of 10 working days prior to the bid date and must be made available to all bidders.
 - 2. 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.

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. Lutron Electronics
5. Substitutions: See Section 016000 - Product Requirements.
6. 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 26 0924 - DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

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 05 39 - Surface Raceways for Communications Systems
- B. Section 26 50 00 - Lighting.
- C. Section 26 52 00 - Emergency Lighting.
- D. Section 25 55 00 - Integrated Automation Control of HVAC- 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 30 00 - 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.

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. Products Warranty: 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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: WattStopper
- B. Substitutions: Hubbell, Greengate, Acuity, Lutron
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

- A. System General: Provide a WattStopper, Provide 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. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
 - 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:
 - 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 Plug Load Controllers: Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
 4. Digital Fixture Controllers: Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
 5. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 6. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 7. 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.
 8. 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.
 9. 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.
 10. 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.
 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, PLUG LOAD 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 and plug load 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
 - 3) Initiate lamp burn in for each load of either 0, 12 or 100 hours
 - 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 ballast or 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 KO Mount Room Controllers shall include:
- 1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 10A total load
 - 2. Optional real time current and voltage monitoring (with - M Monitoring option).
 - 3. One or two relays configurations
 - 4. Smart 150 mA switching power supply
 - 5. Two RJ-45 DLM local network ports. Provide molded strain relief ring
 - 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

7. Units capable of providing both Class 1 or Class 2 wiring for the 0-10V output
 8. WattStopper product numbers: LMRC-111, LMRC-111-M, LMRC-112, or LMRC-112-M.
- D. 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.
- E. 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
- F. Plug Load Controllers shall include:
1. 120 VAC, 60 Hz rated for 20A total load. Controller carries application-specific UL 20 rating for receptacle control.
 2. One relay configuration with additional connection for unswitched load
 3. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
 4. Factory default operation is Auto-on/Auto-off, based on occupancy
 5. Real time current monitoring of both switched and un-switched load (LMPL-201 only)
 6. Switching power supply
 - a. Simple 150mA - Only 4 100 series devices on a Cat 5e local network (LMPL-101)

- b. Smart 250mA (LMPL-201)
 - 7. RJ-45 DLM local network ports
 - a. Three RJ-45 ports (LMPL-101)
 - b. Four RJ-45 ports (LMPL-201)
 - 8. Provide a wireless transmitter that can be connected to any Cat 5e network of the lighting controls that will communicate the room's occupancy state to receptacles mounted in the area with integral relays. Binding of the transmitter to the receptacles shall be accomplished by pressing a test button on the transmitter, and then a test button on the receptacle.
 - 9. WattStopper product numbers:
 - a. Plug Load Controllers: LMPL-101, LMPL-201.
 - b. Wireless Transceiver and Receptacles: WRC-TX-LM, WRC-15-1/2, WRC-20-1/2
- G. 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 (described later in the LMCP LIGHTING CONTROL PANELS specification section).
 - 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 OCCUPANCY SENSOR

- A. Digital Occupancy Sensors shall provide graphic 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, 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. One or two RJ-45 port(s) for 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. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 8. Manual override of controlled loads.
 9. 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.
- 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. 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. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

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. 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.
 9. Configuration LED status light on device that blinks to indicate data transmission.
 10. Status LED indicates test mode, override mode and load binding.
 11. Recessed switch on device to turn controlled load(s) ON and OFF.
 12. 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
 13. One RJ-45 port for connection to DLM local network.
 14. 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.
 15. Any load or group of loads in the room can be assigned to a daylighting zone
 16. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
 17. 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. 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.

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 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 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 networked 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

2.13 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 manager 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.

2.14 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

2.15 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-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: If "REMOTE ACCESS AND ENHANCED WARRANTY FOR NETWORKED SYSTEMS" is specified in Part 1 of this specification, 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.

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 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.

3.5 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 260924

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 260534 - Conduit: Flexible conduit connections.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; current edition.
- B. IEEE C57.94 - Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 1982 (R2006).
- C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 2013.
- D. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; National Electrical Contractors Association; 2009.
- E. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; 2014.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014

- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).
- 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

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Schneider Electric; Square D Products: www.schneider-electric.us.
- B. Eaton Corporation; www.eaton.com.
- C. G.E / ABB.
- D. 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 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

- 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:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
- 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: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 180 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: Comply with 10 CFR 431, Subpart K.

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: 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 3 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. 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 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

THIS PAGE INTENTIONALLY LEFT BLANK

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. Basis of Design: Schneider Electric; Square D Products: www.schneider-electric.us
- B. Eaton Corporation; Cutler-Hammer Products:
- C. Bussman
- D. 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.
- 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 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 Panelboards.

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

PART 1 GENERAL

1.1 PROJECT INCLUDES

- A. Line-voltage wall switches (See Lighting control device Specification for low-voltage lighting controls)
- B. Receptacles.
- C. Wall plates.
- D. Floor box service fittings.
- E. Poke-through assemblies.

1.2 RELATED REQUIREMENTS

- A. Section 260537 - Boxes.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- E. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
- 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 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

- I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- K. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Lutron.
- B. Hubbell.
- C. Wattstopper.
- D. Thomas & Betts.
- E. Leviton.

2.2 APPLICATIONS

2.3 ALL WIRING DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Finishes: Finishes and colors shall be selected by the Architect. Finishes and colors for devices installed at the same height shall match to the greatest extent possible.

2.4 WALL SWITCHES

- A. Manufacturers: Shall match manufacturer of interior lighting controls
- B. All Wall Switches: AC only, quiet operating, decora style switches (for HVAC control, use 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.
 - 2. Wall switches shall match the Lighting Control System as specified in Section 260924.
- C. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with decora style switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.5 RECEPTACLES

- A. Manufacturers:
- B. All Receptacles: 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.
 - 3. Where connected to a Normal/Emergency circuit, provide red receptacles at the direction of the District.
- C. Convenience Receptacles:
- D. GFI Receptacles:
 - 1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
 - 2. Weather Resistant GFI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 - 3. Where connected to a Normal/Emergency circuit, provide red receptacles at the direction of the District.

2.6 WALL PLATES

- A. Manufacturers:
- B. All 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. Provide oversize plates when installed in masonry walls. *Coordinate with Architect for the final decision on the finish and color of plates.*
- D. Weatherproof 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 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.

2.7 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers: Legrand, Evolution Series.
- B. Description: Service fittings compatible with floor boxes provided under Section 260537 with all components, adapters, and trims required for complete installation. Refer to description of devices on the drawings. Physical size shall be determined by both the devices and the cabling/conductors required. Architect shall select the finish and cover style.

2.8 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Legrand, Evolution Series.
- 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. See description on drawings. Refer to description of devices on the drawings. Physical size shall be determined by both the devices and the cabling/conductors required. Architect shall select the finish.

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 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 branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that core drilled holes for poke-through assemblies are in proper locations.
- 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 wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - 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. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- I. Provide GFI receptacles with integral GFI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- M. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- N. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- O. 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.
- P. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- Q. Install poke-through closure plugs in all unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 014000.
- 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. Operate each wall switch with circuit energized and verify proper operation.
- E. Verify that each receptacle device is energized.
- F. Test each receptacle to verify operation and proper polarity.
- G. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- H. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

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

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 262813 – FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.

1.2 RELATED REQUIREMENTS

- A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 2818 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R2007).
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; 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.

1.4 SUBMITTALS

- A. See Section 01 3000 - 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.

1.5 MAINTENANCE MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Furnish two fuse pullers.
- C. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com.
- B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.
- C. Littelfuse, Inc: www.littelfuse.com.
- D. Substitutions: See Section 01 6000 - Product Requirements.

2.2 FUSES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- 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. Main Service Switches Larger than 600 amperes: Class L (time delay), Low-peak.
- H. Main Service Switches: Class RK1 (time delay), Low-peak.
- I. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay), Low-peak.
- J. Power Load Feeder Switches: Class RK1 (time delay), Low-peak.
- K. Motor Load Feeder Switches: Class RK1 (time delay), Fusetron.
- L. Lighting Load Feeder Switches Larger than 600 amperes: Class L time delay, Low-peak.
- M. Lighting Load Feeder Switches: Class RK1 (time delay), Low-peak.
- N. General Purpose Branch Circuits: Class RK1 (time delay), Low-peak.
- O. Motor Branch Circuits: Class L time delay, Fusetron.

PART 3 EXECUTION

3.1 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.

END OF SECTION 262813

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 262818 – ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.
- B. Fusible switches.
- C. Nonfusible switches.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 2813 - Fuses.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- C. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R2007).
- D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).
- 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 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 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D Products: www.schneider-electric.us.
- B. Siemens Industry, Inc: www.sea.siemens.com.
- C. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break, enclosed safety switches complying with NEMA KS 1, type HD (heavy duty), and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. 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 -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.

- I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- J. Enclosures: Comply with NEMA KS 1 and 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:
- K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- L. Heavy Duty Switches:
 - 1. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

2.3 COMPONENTS

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle lockable in OFF position.
 - 3. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.
- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle lockable in OFF position.
- C. Enclosures: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed switches in accordance with manufacturer's instructions.
- B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 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 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Provide identification nameplate for each enclosed switch in accordance with Section 26 0553.
- I. Provide arc flash warning labels in accordance with NFPA 70.
- J. Install fuses in fusible disconnect switches.
- K. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

END OF SECTION 262818

SECTION 263213 - ENGINE GENERATOR

PART 1 GENERAL

1.1 PROJECT INCLUDES

- A. Packaged engine generator system and associated components and accessories:
 - 1. Engine and engine accessory equipment.
 - 2. Alternator (generator).
 - 3. Generator set control system and remote annunciator.
 - 4. Generator set enclosure.
- B. Packaged engine generator set. Prime rated.
- C. Exhaust silencer and fittings.
- E. Battery and charger.
- F. Weatherproof, sound attenuated enclosure.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 233100 - HVAC Ducts and Casings.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260529 - Hangers and Supports for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 263600 - Transfer Switches: Automatic transfer switch.

1.3 REFERENCE STANDARDS

- A. ASTM D975 - Standard Specification for Diesel Fuel Oils; 2011b.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical

Contractors Association; 2010.

- C. NECA/EGSA 404 - Recommended Practice for Installing Generator Sets; National Electrical Contractors Association; 2007.
- D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- F. NFPA 30 - Flammable and Combustible Liquids Code; National Fire Protection Association; 2012.
- G. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2010.
- 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. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2010.
- J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
- K. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
- L. UL 2085 - Protected Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
- M. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
 - a. Transfer Switches: See Section 263600.
- 2. Coordinate the work with other trades to avoid placement of ductwork, piping,

3. equipment or other potential obstructions within the spaces dedicated for engine generator system.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Pre-installation Meeting: Convene one week before starting work of this section.

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 each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
 1. Include generator set sound level test data.
 2. Include characteristic trip curves for overcurrent protective devices upon request.
 3. Include alternator thermal damage curve upon request.
- C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
- E. Specimen Warranty: Submit sample of manufacturer's warranty.
- F. Evidence of qualifications for installer.
- G. Evidence of qualifications for maintenance contractor (if different entity from installer).
- H. 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 operation of product.
- I. Manufacturer's factory emissions certification.
- J. Manufacturer's certification that products meet or exceed specified requirements.
- K. Source quality control test reports.

- L. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
 - 1. Certified prototype tests.
 - 2. Torsional vibration compatibility certification.
 - 3. NFPA 110 compliance certification.
 - 4. Certified rated load test at rated power factor.
- M. Manufacturer's detailed field testing procedures.
- N. Field quality control test reports.
- O. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.
- P. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- Q. Maintenance contracts.
- R. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
- S. 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 of each type and size.
 - 3. Extra Filter Elements: One of each type, including fuel, oil and air.

1.6 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70 (National Electrical Code).
 - 2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
 - 3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
 - 4. NFPA 30 (Flammable and Combustible Liquids Code).
- 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. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.
 - E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
 - F. Products: Listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.
 - G. Conform to requirements of NFPA 70.
 - 1. Maintain one copy of each document on site.
 - H. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.
 - I. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
 - J. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
 - 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 instructions to avoid damage to generator set components, enclosure, and finish.
- 1.8 FIELD CONDITIONS
- A. Maintain field conditions within manufacturers required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- C. Accept unit on site on skids. Inspect for damage.
- D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Packaged Engine Generator Set - Basis of Design: Kohler Power Systems.
- B. Substitutions: MTU and Generac shall be acceptable equals. Contractor shall obtain loads from Engineer and Contractor shall be responsible to verify sizing remains unchanged. Based on the results, the Contractor is responsible to coordinate any differences, providing all necessary equipment and appurtenances to address the differences from the Kohler System.
- C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- D. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.2 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, fuel tank etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. System Description:
 - 1. Application: Standby.
 - 2. Configuration: Single packaged engine generator set operated independently (not in parallel).

C. Packaged Engine Generator Set:

1. Type: Diesel.
2. Basis of Design: Kohler Power Systems
3. Power Rating: 500kW/625kVA, Standby.
4. Voltage: 277/480 volt, three-phase four wire.
5. Main Line Circuit Breaker in interior of unit. Refer to drawings for numbers and sizes.
6. The generator package shall include seismic-rated spring vibration isolators. The unit shall mount to the pad using seismic restraints.

D. Generator Set General Requirements:

1. Prototype tested in accordance with NFPA 110 for Level 2 systems.
2. Factory-assembled, with components mounted on suitable base.
3. List and label engine generator assembly as complying with UL 2200.
4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.

E. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

1. Altitude: 500 feet.

F. Starting and Load Acceptance Requirements:

1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
4. Maximum Load Step: Supports 100 percent of rated load in one step.
 - a. Maximum Voltage Deviation with Load Step: 35 percent.
 - b. Maximum Frequency Deviation with Load Step: 10 percent.
5. Motor Starting Capability: Supports starting of motor load indicated with a maximum voltage dip of 35 percent.

G. Exhaust Emissions Requirements:

1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.

2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.
3. Meet all federal (EPA), state and local requirements for the unit to run as a prime source during power utility curtailment.

H. Sound Level Requirements:

1. Comply with applicable noise level regulations.
 - a. Do not exceed 50 dBA when measured at property line.

I. The generator is sized on a three step approach.

1. Step One - Life Safety (LS) ATS with loads as follows: Lighting, MDF UPS, IDF, MDF, all IDF UPS, fire alarm, sump pump
2. Step Two - Equipment (EM) ATS with loads as follows: Unit Heaters, Cabinet Heaters, Kitchen freezers, Evaporator coil freezer, evaporator cooler coil, condensing unit freezer, condensing unit cooler, admin office, life station, auto flush/sink, ATC, boiler panels.
3. Step Three - Select loads to be delayed by the Building Management System (ATS). Provide a relay contact from the ATS indicating ATS receiving generator feed which will in turn begin the delays for the following loads: IDF/MDF air conditioning, HW pumps, HRU-1, RTU-C1, Boilers, RTU-C3, Heat for Chiller.

2.3 ENGINE

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

1. GM Engines will not be accepted.

B. Engine Fuel System

1. Fuel Source: Diesel
2. Fuel Storage: Dual Wall Sub-base Tank sized for 24Hrs at Full Load.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.

C. Engine Starting System:

1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
 - a. Battery Type: Lead-acid.

- b. **Battery Capacity:** Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
 - c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
 3. **Battery-Charging Alternator:** Engine-driven, with integral solid-state voltage regulation.
 4. **Battery Charger:**
 - a. Provide weather-proof, dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
 - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
 - c. Recognized as complying with UL 1236.
 - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
 - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
 - f. Provide alarm output contacts as necessary for alarm indications.
 5. **Battery Heater:** Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.
- D. **Engine Speed Control System (Governor):**
 1. **Single Engine Generator Sets (Not Operated in Parallel):** Provide electronic isochronous governor for controlling engine speed/alternator frequency.
- E. **Engine Lubrication System:**
 1. **System Type:** Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
 2. **Oil Heater:** Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.
- F. **Engine Cooling System:**
 1. **System Type:** Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
 2. **Fan Guard:** Provide suitable guard to protect personnel from accidental contact with fan.
 3. **Coolant Heater:** Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's

recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

H. Type: Water-cooled inline or V-type, four stroke cycle, electric ignition internal combustion engine.

I. Rating: Sufficient to operate under 10 percent overload for one hour in an ambient of 90 degrees F at elevation of 500 feet.

J. Fuel System: Diesel

K. Engine speed: 1800 rpm.

L. Governor: Isochronous type to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes.

M. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

N. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

O. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 208 volts AC.

P. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator air flow restriction 0.5 inches of water maximum.

Q. Engine Accessories: Fuel tank, fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gage, water temperature gage, and lube oil pressure gage on engine/generator control panel.

R. Mounting: Provide unit with suitable spring-type vibration isolators and mount on structural steel base.

2.4 GENERATOR

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.
- B. Exciter:
 - 1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
 - 2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
 - 3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 1, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.
- G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.5 GENERATOR SET CONTROL SYSTEM

- A. Provide Decision-Maker 550 microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
 - 1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
 - 2. Generator Set Control Functions:
 - a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
 - b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
 - c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
 - d. Emergency Stop: Immediately shuts down generator set (without time delay)

- e. and prevents automatic restarting until manually reset.
- e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
- f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
- g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
- 3. Generator Set Status Indications:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase.
 - c. Frequency (Hz).
 - d. Real power (W/kW).
 - e. Reactive power (VAR/kVAR).
 - f. Apparent power (VA/kVA).
 - g. Power factor.
 - h. Duty Level: Actual load as percentage of rated power.
 - i. Engine speed (RPM).
 - j. Battery voltage (Volts DC).
 - k. Engine oil pressure.
 - l. Engine coolant temperature.
 - m. Engine run time.
 - n. Generator powering load (position signal from transfer switch).
- 4. Generator Set Protection and Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (warning).
 - 6) Low oil pressure (shutdown).
 - 7) Overspeed (shutdown).
 - 8) Low fuel level (warning).
 - 9) Low coolant level (warning/shutdown).
 - 10) Generator control not in automatic mode (warning).
 - 11) High battery voltage (warning).
 - 12) Low cranking voltage (warning).
 - 13) Low battery voltage (warning).
 - 14) Battery charger failure (warning).
 - b. In addition to NFPA 110 requirements, provide the following protections/indications:
 - 1) High AC voltage (shutdown).
 - 2) Low AC voltage (shutdown).
 - 3) High frequency (shutdown).
 - 4) Low frequency (shutdown).
 - 5) Overcurrent (shutdown).
 - 6) Fuel tank leak (warning), where applicable.
 - 7) Remote Emergency Shutdown Activated.
 - c. Provide contacts for local and remote common alarm.

- d. Provide lamp test function that illuminates all indicator lamps.
- 5. Other Control Panel Features:
 - a. Event log.
 - b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.

C. Remote Annunciator:

- 1. Remote Annunciator Mounting: Wall-mounted; provide flush-mounted annunciator for finished area in custodial office.
- 2. Indicators shall include same indications as Generator Warning and shutdown indications.

D. Load Shed Controls:

- 1. Provide Load shed signal from Generator control to Equipment ATS to shed under Generator overload conditions.

E. Remote Emergency Shutdown.

- 1. Provide remote shutdown with glass break cover.

2.6 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective.
- B. Enclosure Material: Steel.
- C. Hardware Material: Stainless steel.
- D. Color: Manufacturer's standard.
- E. Access Doors: Lockable, with all locks keyed alike.
- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material. Provide Level 3 sound attenuated Enclosure.
- I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

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 generator sets and auxiliary equipment are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive equipment.
- E. 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 in accordance with manufacturer's instructions.
 - C. Install securely, in a neat and workmanlike manner, as specified in NECA/EGSA 404.
 - D. Arrange equipment to provide minimum clearances and required maintenance access.
 - E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 033000. Provide suitable vibration isolators, where not factory installed.
 - F. Provide required support and attachment in accordance with Section 260529.
 - G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
 - H. Provide diesel fuel piping and venting in accordance with Section 232113, where not factory installed.
 - J. Provide duct for cooling air intake/exhaust in accordance with Section 233100.
 - K. Provide engine exhaust piping in accordance with Section 235100, where not factory installed.
1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.

- 2. Do not exceed manufacturer's maximum back pressure requirements.
- L. Install exhaust silencer in accordance with Section 235100, where not factory installed.
- M. Provide grounding and bonding in accordance with Section 260526.
- N. Identify system wiring and components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.
- D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- F. Preliminary inspection and testing to include, at a minimum:
 - 1. Inspect each system component for damage and defects.
 - 2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
 - 3. Check for proper oil and coolant levels.
- G. Prepare and start system in accordance with manufacturer's instructions.
- H. Perform acceptance test in accordance with NFPA 110.
- I. Inspection and testing to include, at a minimum:
 - 1. Verify compliance with starting and load acceptance requirements.
 - 2. Verify voltage and frequency; make required adjustments as necessary.
 - 3. Verify phase sequence.
 - 4. Verify control system operation, including safety shutdowns.
 - 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
 - 6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).

- J. Provide field emissions testing where necessary for certification.
- K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.
- L. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- M. Submit detailed reports indicating inspection and testing results and corrective actions taken.
- N. Provide the services of manufacturer's representative to prepare and start system.
- O. Perform field inspection and testing in accordance with Section 014000.
- P. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal.
- Q. Record in 20 minute intervals during four hour test:
 - 1. Kilowatts.
 - 2. Amperes.
 - 3. Voltage.
 - 4. Coolant temperature.
 - 5. Frequency.
 - 6. Oil pressure.
- R. Test alarm and shutdown circuits by simulating conditions.

3.4 ADJUSTING

- A. Adjust generator output voltage and engine speed.

3.5 CLEANING

- A. Clean engine and generator surfaces. Replace oil and fuel filters.

3.6 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 system to Owner, and correct

deficiencies or make adjustments as directed.

- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.
- E. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.7 PROTECTION

- A. Protect installed engine generator system from subsequent construction operations.

3.8 MAINTENANCE

- A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.
- C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
- D. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 4 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts

replaced.

- F. Provide a separate maintenance contract for specified maintenance service.
- G. Provide service and maintenance of engine generator for one year from Date of Substantial Completion.

END OF SECTION 263213

SECTION 26 3600 – TRANSFER SWITCHES

PART 1 GENERAL

1.1 SCOPE

- A. Provide automatic transfer switches (ATS) service entrance rated 800A 277/480V 3PH 4W 3-pole with solid neutral. Each automatic transfer shall consist of an inherently double throw 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.
- B. Provide an enclosure for the (3AUS) that is for service entrance. It shall provide all of the proper disconnecting, protection, grounding and bonding required for service entrance equipment.
- C. Contractor shall provide complete installation for transfer switch.

1.2 ACCEPTABLE MANUFACTURERS

- A. Service entrance automatic transfer switches shall be ASCO Series 3AUS. 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 service entrance automatic transfer switch and accessories shall conform to the requirements of:
 - 1. UL 1008 Listed for Optional Standby Transfer Switches (Manual Transfer Switches)
 - 2. CSA C22.2 No.178 1978
 - 3. IEC 60947-6-1 Low – Voltage Switchgear and Controller
 - 4. NFPA 70 - National Electrical Code
 - 5. NFPA 99 – Essential Electrical Systems for Health Care Facilities
 - 6. IEEE Standard 446 - IEEE Recommended Practice for Emergency and StandbyPower Systems for Commercial and Industrial Applications

7. UL 508 Industrial Control Equipment
8. UL 891 Switchboards
9. NEC Articles 700, 701, 702
10. International Standards Organization ISO 9001: 2008
11. RoHs compliant (Restriction of Hazardous Substances)
12. Seismic qualification – International Building Code & OSHPD to SDS level of 2.5

PART 2 PRODUCTS

2.1 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 overcurrent 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.
- D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand current capability and be protected by separate arcing contacts.
- E. 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.
- F. 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.
- G. Where neutral conductors must be switched, the ATS shall be provided with fully-rated neutral transfer contacts.

- H. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.2 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 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 ± 0.1 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.
61000-4 Testing and Measurement Techniques – Overview
 - 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

2.3 ENCLOSURE

- A. The service entrance 3AUS shall be furnished in a NEMA type 3R 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..
- D. The complete assembly shall be degreased, and thoroughly cleaned through a five-stage aqueous process. The finish shall be ANSI-61, light gray, electrostatically-charged polyester powder paint over a phosphate coating, at a minimum of 2.0 mils in density. Finish shall be suitable for indoor and outdoor environments.
- E. For those automatic transfer switches that are less than 1000 amperes, the connection between the normal disconnecting device and the ATS shall be made with the appropriate size cable. For those automatic transfer switches that are greater than 1000 amperes, the connection between the normal disconnecting device and the ATS shall be made with the appropriate size bus. Bus shall be silver plated copper rated no less than 1000 amps per square inch.
- F. A pressure disconnect link shall be provided to disconnect the normal source neutral connection from the emergency and load neutral connections for 4-wire applications. A ground bus shall be provided for connection of the grounding conductor to the grounding electrode. A pressure disconnect link for the neutral to ground bonding jumper shall be provided to connect the normal neutral connection to the ground bus.
- G. Control wiring shall be rated for 600 volt, UL 1015. Wires shall be placed in wire duct or harnessed, and shall be supported to prevent sagging or breakage from weight or vibration. All wiring to hinged doors shall be run through door terminal blocks or connection plugs.

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)
 - 4. 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).

1.	<u>Parameter</u>	<u>Sources</u>	<u>Dropout/Trip</u>	<u>Pickup/Reset</u>
a.	Undervoltage	N & E	70 to 98%	85 to 100%
b.	Overvoltage	N & E	102 to 116%	2% below trip
c.	Underfrequency	N & E	85 to 98%	86 to 100%
d.	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:
 - 1. 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.
 - 2. 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 in-phase monitor shall be specifically designed for and be the product of the ATS manufacturer. The in-phase monitor shall be equal to ASCO feature 27.

3. 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.
- J. The following feature shall be built – into the controller, but capable of being activated through keypad programming, communications interface port, or additional hardware.
1. 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.
 2. 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,
 - a. Normal Failed
 - 1) Load on Normal
 - 2) TD Normal to Emerg
 - 3) 2min15s
 3. 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.
- K. 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.
- L. 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.
- M. Data Logging – The controller shall have the ability to log data and to maintain the last 300 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
 - c. Data and time and reason for engine start
 - d. Data and time engine stopped
 - e. Data and time emergency source available
 - f. Data and time emergency source not available
2. Statistical Data
 - a. Total number of transfers
 - b. Total number of transfers due to source failure
 - c. Total number of day's controller is energized
 - d. Total number of hours both normal and emergency sources are
 - 1) Available
 - e. Total time load is connected to normal
 - f. Total time load is connected to emergency
 - g. Last engine start
 - h. Last engine start up time
 - i. Input and output status

3.5 OPTIONAL FEATURES

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.
 9. This option shall be equivalent to ASCO accessory 72EE
- F. Transfer Alarm - An audible alarm with silencing feature shall be provided to signal each time transfer to emergency occurs. (This feature shall be equal to ASCO accessory 62W).
- G. Enclosure Heater - A 125-watt enclosure heater with transformer and thermostat (adjustable from 30° to 140 ° F) shall be provided for outdoor installations where type 3R, 4, are specified. (This feature shall be equal to ASCO accessory 44G, and shall be capable of being added to existing switches).
- H. Surge Suppression – A TVSS with a surge current rating of 65kA shall be provided with individually matched fused metal oxide varistors (MOVs). It shall include LED status indication of normal operation, under voltage, power loss, phase loss or component failure. Shall include form C dry contacts for external alarm or monitoring. The unit shall

be enclosed in a Noryl housing rated NEMA 4, 12, and 4X. Shall comply with UL 1449 3rd edition (This feature shall be equal to ASCO accessory 73, and shall be capable of being added to existing switches).

- I. Power Meter – (This feature shall be equal to ASCO accessory 135L, or feature bundle accessory 150*)

- J. *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:

- a. Line-to-neutral voltages (V_{AN} , V_{BN} , and V_{CN})
- b. Line-to-neutral voltage average (V_{AVE})
- c. Line-to-line voltages (V_{AB} , V_{BC} , and V_{CA})
- d.. Line-Line voltage average (V_{LAVE})
- e. Current on each phase (I_A , I_B , and I_C)
- f. Current on the neutral conductor (I_N)
- g. Average current (I_{AVE})
- h. Active power, KW per phase and total (W_A , W_B , W_C , and W_T)
- i. Apparent power, KVA per phase and total (V_{AA} , V_{AB} , V_{AC} , and V_{AT})

KWH_{EXP}, and

1) KWHours importing, exporting and net (KWH_{IMP},

KWH_{NET})

2) KVARHours leading, lagging and net (KVARH_{LEAD}, KVARLAG, and KVARHNET)

j. Power factor (PF)

k. Signal Frequency (Hz)

l. *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.

3.6 DISCONNECTING AND OVERCURRENT PROTECTION DEVICE

- A. For those automatic transfer switches less than 1000 amperes, the normal connection shall be provided with a thermal magnetic rated molded case circuit breaker with current ratings as shown on the plans. It shall have a thermal magnetic trip unit.
- B. For those automatic transfer switches rated above 1000 amperes, the normal connection shall be provided with a stationary mount, insulated case circuit breaker with a solid-state trip unit. The trip unit shall have an adjustable long time, short time, instantaneous, and ground fault trip settings. The insulated case circuit breaker shall trip open when the ground fault setting is exceeded.

3.7 ADDITIONAL REQUIREMENTS

A. Ampere Interrupting Capacity (AIC)

1. The maximum short circuit current the breaker shall be required to interrupt is as follows:

Switch Rating	AIC Rating	Voltage
70 - 225	25,000A	240V
250, 400	50,000A	240V
600	50,000A	240V
800 – 2000	65,000A	240V
2500, 3000	100,000A	240V

3.8 TESTS AND CERTIFICIATION

- A. The complete 3AUS 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 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.

3.9 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 each switch, by serial number, for a minimum of 20 years.
- C. For ease of maintenance and parts replacement, the switch nameplate shall include drawing numbers, part numbers for main coil and control.

END OF SECTION 26 3600

THIS PAGE INTENTIONALLY LEFT BLANK

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 262300 - Low-Voltage Switchgear.
- C. Section 262413 - Switchboards.
- D. Section 262416 - Panelboards.
- E. 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 five 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: Leviton.
- B. Field-installed, Externally Mounted Surge Protective Devices - Other Acceptable Manufacturers:
 - 1. Advanced Protection Technologies, Inc (APT) www.aptsurge.com/#sle.
 - 2. Hubbell.
 - 3. 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 1,000 V 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 1,500 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: Type 1.
 - 2. Outdoor locations: 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.
 - 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.
 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.
 - 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 60 kA per mode/120 kA per phase.
 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.
 - 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.

2.6 SURGE PROTECTIVE DEVICES FOR COMMUNICATIONS WIRING

- A. Provide Surge Protective devices on all communication wiring feeding devices and equipment on the exterior of the building or exterior to the building. Surge Protection shall be provided where the wiring enters the building.

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

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 265100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 PROJECT INCLUDES

- A. Interior luminaires.
- B. Ballasts.
- C. Lamps.
- D. Luminaire accessories.

1.2 RELATED REQUIREMENTS

- A. Section 260537 - Boxes.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 260918 - Remote Control Switching Devices: Remote controls for lighting, including remote control switching relays.
- D. Section 260919 - Enclosed Contactors: Lighting contactors.
- E. Section 260923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- F. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.
- G. Section 265600 - Exterior 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.
 - 3. LED emitters and drivers: Include rated life, color temperature, lumen output of system.
- D. Certificates for Dimming Ballasts and Drivers: Manufacturer's documentation of compatibility with dimming controls to be installed. **The EC shall be responsible for providing and installing all required wiring for control of 0-10v dimming systems.**
- 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.
- 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 manufacturers 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 minimum five year warranty for LED drivers.
- 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.
 - 1. Alternates must be submitted 10 days prior to bid date for approval. Submission does not guarantee approval. If the Contractor obtains approvals and decides to proceed with the Alternate fixtures, the Contractor shall be responsible for verifying the circuiting is adequate and make any necessary changes to accommodate the new fixtures and the Contractor shall be responsible for the recalculation of Comcheck.

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, drivers, reflectors, lenses, housings, mounting accessories 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. Provide LED Drivers with the luminaire as a complete package.

2.4 LAMPS

- A. Manufacturers:
 - 1. Refer to Luminaire Fixture Schedule on the drawings
 - a. Substitutions: See Section 016000 - Product Requirements.
 - b. Manufacturer Limitations: Where possible, provide lamps produced by a single manufacturer.
 - c. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.
- B. All Lamps:
 - 1. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
 - 2. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

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.
7. Provide steel cable support from opposing corners to structure above in addition to the safety clips provided with the luminaire.

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.

I. LED Luminaires as a single continuous fixture with emergency circuit: continuous fixture shall be rated as dual circuit.

J. Install lamps in each luminaire.

K. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

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

SECTION 265600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires.
- B. Poles and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260533.16 - Boxes for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. IEEE C2 - National Electrical Safety Code; 2017.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- E. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- F. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
- G. IES RP-8 - Recommended Practice for Roadway Lighting; 2014.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- I. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.

- J. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2016.
- K. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
- L. NFPA 70 - National Electrical Code; 2017.
- M. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- N. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- O. 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 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 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.
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.

2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
3. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

D. Samples:

1. Provide one sample(s) of each luminaire proposed for substitution upon request.
2. Provide one sample of each product finish illustrating color and texture upon request.

E. 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.

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.

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, 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 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five 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.
- 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, 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.
- H. 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.
- I. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.
- J. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.

3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

K. Exposed Hardware: Stainless steel.

2.3 POLES

A. All Poles:

1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
2. Structural Design Criteria:
 - a. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.

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 260533.16 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. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Pole-Mounted Luminaires:
 - 1. Foundation-Mounted Poles:
 - a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 033000.
 - 1) Install anchor bolts plumb per template furnished by pole manufacturer.
 - 2) Position conduits to enter pole shaft.
 - b. Install foundations plumb.
 - c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
 - d. Tighten anchor bolt nuts to manufacturer's recommended torque.
 - e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
 - f. Install anchor base covers or anchor bolt covers as indicated.
 - 2. Grounding:
 - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
 - 3. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
- 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 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.
- 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 017800 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- C. 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 265600

THIS PAGE INTENTIONALLY LEFT BLANK

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 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 3 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 3 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 an RCDD (Registered Communications Distribution Designer). Provide proof of certification with submittals.

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 15 period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cabling and Equipment:

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 and cabinets, 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 street 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 EC specified below
 - a. 1 Liebert GXT4-3000RT120 with IS-Webcard per wiring closet (MDF/IDF).
 - b. 2 Eaton ePBZ85 PDU's per wiring closet (MDF/IDF).
 - 1) PDU's must mount horizontally in rack.
- B. Capacity:
1. Building Entrance: Coordinate Service Entrance with Owners Vendor Crown Castle.
 2. Horizontal Cabling
 - a. MDF
 - 1) CAT 6 cabling to outlet ports:
 - (a) Refer to the drawings for exact counts of ports per outlet device.
- 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 Backbone Cable: TIA/EIA-568 Category 5E solid conductor unshielded twisted pair (UTP), 24 AWG, 100 ohm, 25 pair; covered with gray thermoplastic jacket and complying with all relevant parts of and addenda to latest editions of TIA/EIA-568 and ICEA S-90-661, and UL 444. Cable shall be Mohawk #M58142. Equivalent cables manufactured by Belden, Essex, General may be acceptable.
 - 1. In plenums, provide NFPA 70 type CMP plenum-rated cable.
 - 2. Provide cable having conductors twisted at minimum rate of two per foot; actual length and frequency of twists at manufacturer's option.
 - 3. Color code conductors in accordance with ICEA S-90-661.
 - 4. Testing: Furnish factory reel tests.
- B. 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. Equivalent cables manufactured by Belden, Essex, General may be acceptable.
 - 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 for Wireless Access Points – Green.
 - b. Data Drops (standard drops) – Green.
 - c. Data Drops for Video Cameras – Purple.
 - d. Data Drops for Security Door Access – White
 - e. Data Drops for Control Systems – blue.
- C. Copper Cable Terminations:
 - 1. Each cable color type (a,b,c,d) shall be landed in own patch panel. Ie) all the red keystone jacks in one panel, black in another, yellow in another.
 - 2. 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 or equivalent.

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 ends within 1 foot of cable termination.

2.7 CROSS-CONNECTION EQUIPMENT

- A. Connector Blocks for Category 6 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 UDX24E/UDX48E with PCMBR4 Rear cable 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 consecutively; comply with TIA/EIA-606 using encoded identifiers.
 - 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 for MDF/IDF(s) shall be Lynn Electronics Opti link 6 cables one (1) foot in length. Patch cord color shall match keystone jack color on patch panel.
 - b. Patch cords for rooms shall be Lynn Electronics Opti Link 6 cables seven (7) foot in length. Patch cord color shall be blue.
- C. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum. Fiber patch panel for each IDF - Hubbell FCR1U3SP –

1U 36 SC Ports. Fiber patch panel for each MDF - Hubbell FCR3U12SP – 3U 144 SC Ports.

1. Adaptors: As specified above under FIBER OPTIC CABLING;
2. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers. Shall be machine print.
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.

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 gage steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug. Provide Hubbell #HPW84RR19D, with HM27C Horizontal Manager, and Vertical Cable Managers VME614C2
 2. Provide 2-post racks (Hubbell HPW90RR19).
 3. Provide wall mounted cabinet where indicated.
- 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 as to its function with a unique numerical identifier.

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.
- 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 - Copper: 12 inches.
3. At Outlets - Optical Fiber: 39 inches.

C. Copper Cabling:

1. Category 6: 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. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

E. 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 as to its type and function, with a unique numerical identifier.
3. Patch Panels: Label each jack as to its type and function, with a unique numerical identifier.
4. Patch Cords: Label with jack identifier corresponding to initial installation.
5. **The Contractor shall label Camera, Door Access, and Building Automation with the Equipment I.P. Address for which it serves. For equipment furnished by the Owner, the Contractor shall obtain I.P. Addresses from the Owner and label the cable as required. (Addendum 05)**

F. Each data rack shall consist of the following (in order from top to bottom).

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

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 6 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.
- E. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION 271005

SECTION 276000 – BOARD ROOM AV 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.

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 board room shall be provided with a complete locally controllable AV 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. 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

3. Provide a complete Extron AV system as shown on the drawings. The manufacturer's latest published specifications shall be considered as part of this text. Quantities shown on the contract drawings. Provide the following components including all necessary interconnecting wiring and devices for a complete and working system:
 - a. Extron DTP Crosspoint 108 4K IPCP Q MA 70, 10x8 seamless 4K scaling presentation matrix mixer with power audio amplifier
 - b. Extron DMP 128, 12x8 ProDSP digital matrix processor
 - c. Extron Sharelink Pro 1000, wired and wireless presentation gateway.
 - d. Extron DTP T UWP 4K 232 D, Input DTP transmitter
 - e. Extron PI 115, Power injector
 - f. Extron DTP HDMI 4K 231 D, DTP HDMI receiver
 - g. Extron TLP Pro 725, 7" wall mounted touch panel
 - h. Extron TLP Pro 1025T, 10" Tabletop touch panel
 - i. Extron WPB 109, AV input wall plate
 - j. Extron DTP HD DA 4K 230 output DTP distro amp
 - k. Extron DTP HDMI 4K 230 Tx DTP transmitter for HDMI
 - l. Extron DTP HDMI 4K 230 Rx DTP transmitter for HDMI
 - m. Extron eLink 100 wireless extenders for HDMI
 - n. 18 Port PoE++ AV switch

4. Provide Extron SMP 351 streaming media processor. The unit shall feature:
 - a. Process two high resolution AV sources from up to five available input signals — Size and position two AV source signals in layouts that maximize the viewing experience.
 - b. Record and stream simultaneously — Document presentations, view confidence streaming, or extend live media to overflow destinations without the need for a computer or additional equipment.
 - c. High quality scaling with flexible two-window management — Display one or two high resolution sources in various window arrangements, including picture-in-picture and picture-by-picture arrangements for optimal interpretation.
 - d. Produce MP4 media or M4A audio files that are compatible with virtually any media player — Use recordings produced by the SMP 351 directly with any software media player, computer, or mobile device.
 - e. Produce MP4 media or M4A audio files that are compatible with virtually any media player — Use recordings produced by the SMP 351 directly with any software media player, computer, or mobile device.
 - f. Internal Solid State Storage — Save recorded data to reliable, internal storage, before transferring it to external destinations. Capacity of 128 GB (110 GB for recording files) or 480 GB (440 GB for recording files). Up to 40 hours of material can be saved to the 128 GB version, or 150 hours to the optional 480 GB version, encoded at 10 Mbps.
 - g. Internal Solid State Storage — Save recorded data to reliable, internal storage, before transferring it to external destinations. Capacity of 128 GB (110 GB for recording files) or 480 GB (440 GB for recording files). Up to 40 hours of material can be saved to the 128 GB version, or 150 hours to the optional 480 GB version, encoded at 10 Mbps.
 - h. Internal Solid State Storage — Save recorded data to reliable, internal storage, before transferring it to external destinations. Capacity of 128 GB (110 GB for recording files) or 480 GB (440 GB for recording files). Up to 40 hours of material can be saved to the 128 GB version, or 150 hours to the optional 480 GB version, encoded at 10 Mbps.

5. Provide Extron XPA U 1002, two channel low and high impedance amplifier. The audio amplifier shall feature:
 - a. Two channels at 70V
 - b. Two balanced/unbalanced inputs
 - c. 100 watts per channel, 70V, 1 kHz, 0.1% THD
 - d. Convection cooled, fanless operation
 - e. Defeatable auto-standby with fast wake up
 - f. Automatic clip limiter
 - g. High pass filter for high impedance model

6. Provide Extron MPA 601-70V, mono 70/100V amplifier. The audio amplifier shall feature:
 - a. Single channel, 60 watts rms output power

- b. Inputs: balanced or unbalanced stereo or mono on a captive screw connector; unbalanced stereo or mono on RCA connectors; 3.5 mm stereo mini jack
 - c. Convection cooled, fanless design with UL 2043 plenum rated enclosure
 - d. Balanced and unbalanced buffered audio inputs
7. Loudspeakers: Provide Extron 26CT #60-1310-03 recessed ceiling speakers. Two-Way Ceiling Speaker with 8" Composite Back Can and 70/100 V Transformer:
- a. 6.5" (165 mm) long throw woofer with a tuned bass reflex enclosure
 - b. 3/4" (19 mm) ferrofluid-cooled dome tweeter
 - c. 8" (203 mm) deep composite back can for plenum environments
 - d. Frequency range: 65 Hz to 22 kHz 111° conical dispersion
 - e. 65 watts continuous pink noise, 130 watts continuous program
 - f. Locking arms support ceilings up to 2.25" (57.1 mm) thick
8. Provide Panasonic AW-UE150 PTZ camera or equal. The PTZ camera shall feature:
- a. Imaging - Sensor Type: 1"-Type MOS Sensor, Horizontal Resolution (TV Lines): 1600 TV Lines, Image Stabilization: Optical in Integrated Lens, Focus Control: Autofocus & Manual Focus
 - b. Exposure Control - Shutter Speed: 1/10000 to 1/24 Second, Gain: 0 to 42 dB (Expanded), Sensitivity: f/9 at 2000 lux, Signal-to-Noise Ratio: 60 dB, White Balance: 2000 to 15,000K
 - c. Lens - Focal Length: 8.8 to 176mm (35mm Equivalent Focal Length: 24.5 to 490mm), Optical Zoom Ratio: 20x, Max Digital Zoom: 32x (in 1080p), Maximum Aperture: f/2.8 to 4.5, Minimum Focus Distance: Wide: 3.9" / 9.9 cm - Telephoto: 39.6" / 100.6 cm
 - d. Video Capture - External Recording Modes:
SDI/BNC / HDMI / RJ45 / Optical Fiber:
3840 x 2160 at 24.00/25/29.97/50/59.94 fps, 1920 x 1080p at 25/29.97/50/59.94 fps, 1920 x 1080PsF at 23.98/25/29.97 fps, 1920 x 1080i at 50/59.94 fps, 1280 x 720 at 50/59.94 fps, Broadcast Output: NTSC/PAL, IP Streaming: H.264, H.265, MJPEG: 1920 x 1080 and 1280 x 720

- e. Control - Move Speed: Pan: 0.08 to 180°/sec, Tilt: 0.08 to 180°/sec, Movement Range: Pan: 350° (-175 to 175°), Tilt: 120° (-30 to 210°), Tally Light: Yes, Supported Control Protocols: RS-232 & RS-422
 - f. Interface - Video I/O: 1 x HDMI 2.0 Output, 1 x BNC Loop Output, 1 x BNC (3G-SDI) Output, Audio I/O: 1 x 1/8" / 3.5 mm TRS Stereo Mic/Line Input, Other I/O: 1 x BNC (Genlock) Input, 1 x RJ45 (RS-422) Control
 - g. Power - PoE Support: PoE++ 802.3bt, Power I/O: 1 x Proprietary (10.8 to 13.2 VDC), Power Consumption: Power Supply: 10.8 to 13.2 VDC at 4 A, PoE: 42 to 57 VDC at 1.2 A
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 remote power ON/OFF/Sequencing:
 - 1) Juice Goose RC-DM3 power control combiner.
 - 2) Juice Goose RC5-WM power sequence control.
 - 3) Juice Goose CQ-PD1-4 four step power sequencer.
10. Rack Enclosure: Provide Chief Manufacturing steel rack or equal. Provide rack with enough space to accommodate all equipment that will be installed in the rack for the system specified. Audio rack shall accommodate equipment to a standard rack width of nineteen inches. Included shall be a lockable rear door and a lockable perforated front door. Quantities listed on the drawings. Provide all necessary mounting hardware for equipment and wiring.
11. 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.

12. Microphones and cables:
- a. Wireless Microphones: Provide (2) Shure SLXD124/85 or equal, diversity receiver with one handheld microphone transmitter and wireless lavalier transmitter.
 - b. Provide Shure MXCW640 wireless digital conference system. Provide equipment and quantities as shown on the bid documents. Provide all equipment required for a complete system.
 - c. Provide (2) Shure SM58-CN cardioid, dynamic microphones.
 - d. (2) XLR male to XLR female shielded microphone cables, (25) feet in length
 - e. (2) 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.
 - f. Provide (1) podium mounted gooseneck microphone mount with compatible clamp for the Shure handheld microphones.
13. Assistive Listening System. Provide (5) bodypacks and (5) Headphones. The system shall be Williams Sound PPA T45 or equal. Front Panel: The PPA T45 shall have a push button controlled LCD digital display. There shall be three pre-configured (selectable) application presets: Hearing Assist, Music and Voice. Configurations for Bandwidth, Frequency, Audio Input Source (Microphone, Line, Simplex), High Pass Filter, Low Pass Filter, Compressor Slope, Compressor Gain and RF Output Power shall be push button controlled. The audio level shall be adjustable by push button control. There shall be a 10 LED array showing +9 to -18 at 3dB intervals. The PPA T35 shall have a 1/4" phone jack with push button volume control. It shall have push button control for monitoring source audio or transmitted audio. It shall have an input overload indicator. It shall have an "on" indicator and power button.

Rear Panel: The PPA T45 shall be powered by 24 VAC power supply via a 3-pin Molex® connector. It shall have a 75 ohm F-connector antenna. It shall have an ANT 025 whip antenna on the top panel directly connected to the circuit board. The transmitter shall have an RCA line output jack. It shall have a combination 1/4" phone/XLR audio input jack. It shall have an RF "Off" timer that turns off RF signal after 1 hour of no audio activity. The PPA T35 shall have FCC, RoHS, and WEEE approval and be powered by UL and CSA power supply. It shall have a 5-year parts and labor warranty. It shall be compatible with Williams Sound FM equipment operating on 72-76 MHz. The transmitter shall be a Williams Sound Corp. model number PPA T35.

The PPA T45 transmitter shall be microprocessor controlled with push button configuration. It shall have an operating range of up to 1000 feet. It shall have 10 wideband and 7 non-standard wideband channels operating on 72.1–75.9 MHz. It shall have 77 narrowband channels operating on 72.025–75.975 MHz.

PPA R35 Receiver: The R35 receiver shall be encased in a black, PC/ABS impact-resistant plastic with a hinged door for battery installation. The receiver shall be a body-pack type and include a detachable belt-clip for hands-free operation. The receiver shall have a 3.5 mm mono phone jack and accommodate low-impedance mono earphones, headphones, neckloops, and telecoil couplers. The receiver shall

have a combination volume control and power on/off rotator dial, and a green LED power "on" indicator. The LED power "on" indicator shall illuminate red to indicate low battery power. There shall be a screwdriver adjustable tuning pot accessible through the battery door. There shall be a slide selection switch located through the battery door for choosing Alkaline or NiMH battery operation. There shall be drop-in charger contacts on the bottom of the receiver unit.

The receiver shall be pre-tuned to one of 17 available channels from 72- 76 MHz and field adjustable by internal tuning coil. The receiver shall operate up to approx. 100 hours when using 1.5 V AA Alkaline batteries, and shall operate up to approx. 50 hours when using 1.5 V NiMH rechargeable AA batteries. The receiver shall receive FM signals in the 72-76 MHz audio assistance band with 75 μ S de-emphasis. The receiver shall provide a maximum output of 35 mW at 16 Ohms with an earbud-type earphone. The system's electrical frequency response shall be 100 Hz to 15 kHz, \pm 3 dB and the signal-to-noise ratio shall be 65 dB at 10 μ V. The receiver shall have a sensitivity of 2 μ V at 12 dB Sinad. The receiver shall have FCC, Industry Canada approvals, and be compliant with RoHS and WEEE regulations. The receiver shall be covered by a five years parts and labor warranty, excluding earphones, headphones, batteries and chargers.

PART 3 – EXECUTION

3.1 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

3.2 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.

3.3 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 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.

3.4 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.

3.5 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.

3.6 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 276000

SECTION 277000 – CONFERENCE ROOM AV 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.

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 Executive Conference and Conference Breakout rooms shall be provided with a complete locally controllable AV 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. Provide a complete Extron AV system as shown on the drawings. The manufacturer's latest published specifications shall be considered as part of this text. Quantities shown on the contract drawings. Provide the following components including all necessary interconnecting wiring and devices for a complete and working system:
 - a. Extron DTP2 Crosspoint 82 IPCP MA 70, 8x2 seamless 4K/60 scaling presentation matrix mixer with power audio amplifier
 - b. Extron DTP T UWP 4K 232 D, Input DTP transmitter
 - c. Extron PI 115, Power injector
 - d. Extron DTP HDMI 4K 231 D, DTP HDMI receiver
 - e. Extron TLP Pro 725, 7" wall mounted touch panel
 - f. Extron WPB 109, AV input wall plate
 - g. Extron DTP HDMI 4K 230 Tx DTP transmitter for HDMI
 - h. Extron DTP HDMI 4K 230 Rx DTP transmitter for HDMI
 - i. Extron IN1604 DTP four input HDCP-Compliant scaler

- j. Extron IPL Pro S3 IP link pro control processor
 - k. 8 Port PoE++ AV switch
3. Provide Extron Cable Cubby TLP Pro 725C & 700 series. Provide retractor cables for HDMI, Display Port, Audio, and VGA as shown on the drawings.
 4. Provide Extron XPA U 1002, two channel low and high impedance amplifier. The audio amplifier shall feature:
 - a. Two channels at 70V
 - b. Two balanced/unbalanced inputs
 - c. 100 watts per channel, 70V, 1 kHz, 0.1% THD
 - d. Convection cooled, fanless operation
 - e. Defeatable auto-standby with fast wake up
 - f. Automatic clip limiter
 - g. High pass filter for high impedance model
 5. Provide Extron MPA 601-70V, mono 70/100V amplifier. The audio amplifier shall feature:
 - a. Single channel, 60 watts rms output power
 - b. Inputs: balanced or unbalanced stereo or mono on a captive screw connector; unbalanced stereo or mono on RCA connectors; 3.5 mm stereo mini jack
 - c. Convection cooled, fanless design with UL 2043 plenum rated enclosure
 - d. Balanced and unbalanced buffered audio inputs
 6. Loudspeakers: Provide Extron 26CT #60-1310-03 recessed ceiling speakers. Two-Way Ceiling Speaker with 8" Composite Back Can and 70/100 V Transformer:
 - a. 6.5" (165 mm) long throw woofer with a tuned bass reflex enclosure
 - b. 3/4" (19 mm) ferrofluid-cooled dome tweeter
 - c. 8" (203 mm) deep composite back can for plenum environments
 - d. Frequency range: 65 Hz to 22 kHz 111° conical dispersion
 - e. 65 watts continuous pink noise, 130 watts continuous program
 - f. Locking arms support ceilings up to 2.25" (57.1 mm) thick

7. AV Ceiling Enclosure: Provide Chief Manufacturing #CMS492P2, 2x2 ceiling storage box with 2-gang filter and surge protection.
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.

PART 3 – EXECUTION

3.1 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

3.2 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.

3.3 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 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.

3.4 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.

3.5 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.

3.6 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 276000

SECTION 278000 – SOUND MASKING 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.

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 open office areas shall be provided with a complete locally controllable sound masking 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. Provide AtlasIED 4-Zone high definition acoustical system #Z4-B. The sound masking system shall feature:

The AtlasIED Model Z2-B & Z4-B shall be an amplified multi zone Speech Privacy Sound Masking, paging BGM system. The Z Series shall provide one balanced Mic / Line, AUX L & R Summed Unbalanced inputs and Bluetooth® streaming input. The Z Series shall incorporate BLE® and 900MHz wireless technology for remote indication and control. The Z2-B shall provide two independent analog noise generators with separate assignable system commission ramps for Speech Privacy. The Z2-B shall deliver 60-Watts of power into a 70V system. The Z4-B shall provide four independent analog noise generators with separate assignable system commission ramps for Speech Privacy. The Z4-B shall deliver 120-Watts of power into a 70V system.

The Z Series shall incorporate a front panel digital display with password protected navigational keys to access and adjust factory preset project files. Project files included shall be for speech privacy masking applications for Open Ceiling, Above Ceiling, Below Floor, Direct Field, Indirect Field and Enhanced Speech Privacy. The Z Series shall have PC Based software to create custom project files to upload via USB drive.

The Z Series shall include an "Enhanced Privacy" system for high security applications. Enhanced Privacy activation shall be done remotely via hardwired contact closure, iOS® / Android® App or via the optional AtlasIED wireless Z-SIGN. The Z Series shall transmit when Speech Privacy is engaged via hard wired 10VDC output to power an optional Enhanced Privacy sign or wirelessly transmit to the optional Z-SIGN. Enhanced Privacy configuration settings shall be adjustable via the front panel navigation keys.

The Z Series shall support paging, message playback or BGM audio. The Z Series Mic / Line input shall be Euro / Phoenix type connector. The AUX input on rear panel shall be a 3.5mm stereo (summed) jack. The Bluetooth® streaming protocol shall be of the 4.1 standard. The audio input sensitivity shall be Mic 5mV, Line 500mV, and AUX / Bluetooth® variable 316mV – 1V. Each of the Mic / Line and AUX / Bluetooth® inputs shall have independent input level control accessed via the front panel navigation keys. DSP Equalization shall be fixed per Project File Preset. The Z Series shall have PC Based software to create project files with custom EQ, routing, mixing and level adjustments.

The Z Series shall incorporate two types of speaker connectivity, Euro block / Phoenix 5.08mm pitch connectors to support two conductor wire and RJ45 jacks to support a multiple multi conductor cable. The Z Series shall meet low voltage Class-2 wiring electrical code requirements, eliminating the need to run the wire in expensive conduit.

Frequency Response shall be 50Hz-15kHz (with DSP set to Flat). Dynamic Range shall be greater than 90dB below rated output (A-Weighted). Power Consumption shall be less than 20W average under normal use for the Z2-B and 40W for the Z4-B. Dimensions shall be W 10.7" x H 8.17" x D 2.32" (272mm x 208mm x 59mm). Weight shall be 7.7 lbs (2.8 kg) for the Z2-B and 10 lbs (3.77 kg) for the Z4-B. Warranty coverage shall be 3-year. The unit shall be CE marked, RoHS/WEEE, TUV, GMA (power Supply) compliant and UL certified. The Z2 & Z4 shall meet low voltage wiring standards. The High Definition Acoustical Systems for Speech Privacy, Paging, and BGM Amplifier shall be an AtlasIED Z2-B & Z4-B.

3. Loudspeakers: Provide AtlasIED #M1000, 8" dual cone sound masking speaker or equal. Unit shall contain Atlas Sound 8" diameter Loudspeaker equipped with a 70.7V transformer, an enclosure, baffle, and related mounting hardware. It shall be factory assembled, wired and ready for installation. Model M1000 shall include external tap selector switch with an off position and .25 .5, 1, 2, & 4 watts power taps clearly identified. Model M1000-W shall include an external tap selector switch with an off position and .25 .5, 1, 2, & 4 watts power taps and an 8 Ω bypass clearly identified. Suitable strain relief shall be installed to protect hook-up leads and accommodate conduit installations. Provisions on input panel also included to facilitate up to 3/4" conduit.

The CRS enclosure shall measure 119/16" (243 mm) L x 119/16" (243 mm) W x 51/2" (140 mm) H and have a volume of 734 in³ (12,075.1 cm³). It shall include fiberglass material to further dampen the enclosure. Baffle shall be a sturdy steel one-piece CRS grille measuring 119/16" (243 mm) L x 119/16" (243 mm) W. Grille shall have a perforated loudspeaker opening. Baffle and enclosure shall be finished in textured black epoxy or white epoxy finish on the M1000-W. Assembly shall include a dual suspension hanger system which fastens via holes provided on the enclosure.

PART 3 – EXECUTION

3.1 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

3.2 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.

3.3 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 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.

3.4 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.

3.5 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.

3.6 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 276000

SECTION 281300 - ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access Control Hardware Software Integrations.
 - 2. Access Control Software Administration.
 - 3. Accessory Software Schedule.
- B. Related Sections:
 - 1. Section 08 71 00 - Door Hardware
 - 2. Section 28 31 11 – Building Intrusion Detection System.
- 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 DISTRICT VENDOR AND DIVISION OF RESPONSIBILITY

- A. The Contractor will be required to coordinate the full and complete installation with the District's Vendor. The E.C. Shall provide all wiring, conduits, components, software and hardware required for a complete and operational system except for the following:
 - 1. Mercury boards and safety cans Shall be furnished by the District/District Vendor for installation by the E.C.
 - 2. Wiring connections and testing of wiring shall be performed by the Districts Vendor.
 - 3. All programming shall be performed by the Districts Vendor.
- B. All equipment shall be purchased from an authorized Avigilon dealer to ensure compatibility with the existing District door access system. The Contractor is strongly encouraged but not required to purchase from the Districts Vendor.
- C. District's Vendor Information

1. Vendor: Triangle Communications Inc.
2. Contact Name: Jerry Fox
3. Address: 940 West Main St., New Holland, PA 17557
4. Email: j.fox@trianglesc.com
5. Phone: 717-656-2211

1.3 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.

1.4 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.

1.5 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.

1.6 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.
 - 1. Address: 415 E Exchange Pkwy Allen, TX 75002 Phone: (888) 281-5182.
 - 2. Website: www.avigilon.com.
- A. Manufacturer List:
 - 1. Motorola Solutions: Access Control Manager.
- B. Substitution Limitations:

1. No Substitutions permitted. This System is an extension of the existing District-wide access control system.

2.2 ACCESS CONTROL SOFTWARE

- A. Basis of Design: Access Control Manager, by Motorola Solutions.
- 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.
 - 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: Signo.Keypad Reader 40K
- D. Request to Exit:
1. Bosch DS160 series minimum or equal.
 2. Color to match mounting surface.
- E. Network Video Door Station (For Main Entry)
1. Description: Integrated 6MP camera, Card Reader, Keypad, Intercom.
 2. Axis Model: A8207-VE Mk II

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.
- B. Prior to release of equipment order, Coordinate with Owners Vendor.
 1. Verify system and wiring requirements.
 2. Verify all proposed components are compatible with Owners District system and will result in a complete and operational system.
- C. Verify Field Measurements.

3.2 INSTALLATION

- A. Label all wiring in accordance with Owner and Owner's vendor requirements.
- B. 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.
- C. Ensure products are equipped with latest and most up-to-date firmware and/or software by manufacturer.

- D. 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).
- E. No system/product default passwords allowed.
- F. Coordinate final connections and programming of System with Owner's Vendor.
- G. Replace any wiring damaged during installation or wiring which does not pass testing performed by the Owners Vendor.

3.3 CLOSEOUT ACTIVITIES

- A. As-Built Drawings:
 - 1. Provide As-Built Drawings to Owner. Include device locations, wiring etc.

END OF SECTION 281300

SECTION 283111 - BUILDING INTRUSION DETECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Intrusion detection system requirements.
- B. Alarm control unit.
- C. Keypads.
- D. Initiating devices.
- E. Alarm notification appliances.
- F. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 7100 - Door Hardware: Electrically operated locks and door holder devices to be monitored and controlled by intrusion detection system.
- C. Section 26 0526 - Grounding and Bonding 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 28 1000 - Access Control: For interface with intrusion detection system.
- G. Section 28 2000 - Video Surveillance: For interface with intrusion detection system.
- H. Section 28 4600 - Fire Detection and Alarm.

1.3 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- 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.
- D. UL 609 - Local Burglar Alarm Units and Systems; Current Edition, Including All Revisions.

- E. UL 634 - Connectors and Switches for Use with Burglar-Alarm Systems; Current Edition, Including All Revisions.
- F. UL 639 - Intrusion-Detection Units; Current Edition, Including All Revisions.
- G. UL 864 - Control Units and Accessories for Fire Alarm Systems; Current Edition, Including All Revisions.
- H. UL 1037 - Antitheft Alarms and Devices; Current Edition, Including All Revisions.
- I. UL 1610 - Central-Station Burglar-Alarm Units; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of devices for the installed locations with work provided under other sections or by others.
 - 2. Coordinate the placement of sensors and keypads with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 3. Coordinate the work with other installers to provide communication lines required for alarm control unit connection to central station.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install sensors and keypads until final surface finishes and painting are complete.

1.5 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 system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
- C. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
- D. Certify that proposed system design and components meet or exceed specified requirements.
- E. Evidence of qualifications for installer.
- 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 operation of product.

- G. Field quality control test reports.
- H. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- I. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- J. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

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. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with intrusion detection systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized representative of control unit manufacturer.
- E. 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, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products in manufacturer's unopened packaging, keep dry 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 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 INTRUSION DETECTION SYSTEM REQUIREMENTS

- A. Provide new intrusion detection system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Alarm Control Unit: New addressable alarm control panel located In IDF/MDF Closets and Electrical Rooms.
- C. Combination fire/intrusion systems are not permitted.
- D. Keypads: Located as indicated.
- E. Initiating Device Requirements:
 - 1. Protected Premises: Entire building as indicated.
 - 2. Provide magnetic contacts to monitor opened/closed position for:
 - a. All perimeter doors and windows.
 - b. Designated interior doors.
 - 3. Provide motion detectors to detect intruder in designated areas.
- F. Alarm Notification and Reporting Requirements:
 - 1. Activate alarm notification at alarm control unit and associated keypads/annunciators with appropriate zone information displayed.
 - 2. Activate local notification appliances.
 - a. Interior: Provide siren located Provide minimum of 10 sirens within the building..
 - 3. Transmit alarm report to listed remote central station under contract with facility.
 - a. Primary Communication Means: Digital cellular communications.
 - b. Secondary Communication Means: Internet/intranet (IP addressing).
- G. Interface with Other Systems:
 - 1. Provide products compatible with other systems requiring interface with intrusion detection system.
 - 2. Interface with access control system as specified in Section 28 1000.
 - a. Capable of affecting access for designated doors for selected intrusion detection system events.
 - b. Capable of affecting intrusion detection system status for selected access control system events.
 - 3. Interface with video surveillance system. 28 2000
 - a. Capable of activating video surveillance system and controlling camera inputs/video outputs for selected intrusion detection system events.
 - 4. Interface with electrically operated door hardware as specified in Section 08 7100.
 - a. Capable of locking/unlocking/releasing designated doors for selected intrusion detection system events.

- H. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 1. Local Alarm Units and Systems: Listed and labeled as complying with UL 609.
 - 2. Central Station Alarm Units: Listed and labeled as complying with UL 1610.
- I. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.2 ALARM CONTROL UNIT

- A. Manufacturers:
 - 1. Addressable Alarm Control Panel - Basis of Design: Bosch.
 - 2. Addressable Alarm Control Panel:
 - a. Bosch Security Systems; www.boschsecurity.us/#sle.
 - b. Manufacturer Model: B9512G
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
 - 4. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. Any Substitution must integrate seamlessly with Avigilon door Access System.
- B. Alarm Control Panel: Modular construction.
 - 1. Enclosure: Lockable; provide tamper protection.
 - 2. Power Supply:
 - a. Primary Power: 120 VAC; provide suitable transformer/power supply; supervised for loss of AC power.
 - b. Secondary Power: Standby battery; provide suitable capacity for minimum standby time required by listing requirements, applicable codes, and authority having jurisdiction, but not less than four hours; provide suitable battery charger; supervised for low battery condition; protected from accidental reversal of battery leads.
- C. Alarm Initiating Circuits: Supervised.
 - 1. Hardwired Zones: Supports both normally closed and normally open conventional (non-addressable) initiating devices.
 - 2. Addressable Zones: Supports addressable initiating devices and modules using multiplexed polling loops.
- D. Alarm Notification Circuits: Supervised.
- E. Communications Interfaces: Supervised.
 - 1. Supports system reporting to central station receivers via integral interface or accessory interface modules using:
 - a. Telephone lines.
 - b. Digital cellular network.
 - c. Internet/intranet (IP addressing).
- F. Keypads: Supervised.

- G. Peripheral Devices: Supervised; provide tamper protection.
- H. Output Relays:
 - 1. Relay Modules: Form C relays (normally open and normally closed); provide tamper protection.
 - 2. Programmable to respond to system events, according to defined scheduling, or by manual activation from keypad.
- I. User Codes:
 - 1. Each user code to be individually assignable to any defined authority level for configurable access to system features and functions.
- J. Partitions:
 - 1. Each partition to operate independently with individually programmable annunciation, control, and reporting functions.
 - 2. Each zone to be individually assignable to any partition.
 - 3. Each keypad to be individually assignable to any partition.
 - 4. Each output relay to be individually assignable to any partition.
 - 5. Each user code to be individually assignable to any partition.
 - 6. Minimum Number of Partitions Supported: Four.
- K. Scheduling:
 - 1. Provide time/calendar-based scheduling capability for automated system control.
 - 2. Supports open/close schedules for control of arming/disarming and reporting.
 - 3. Supports timed events including, but not limited to:
 - a. Point bypass/unbypass.
 - b. Relay activate/deactivate.
- L. Event Log:
 - 1. Stores system events including time, date, partition, zone, and user code where applicable.
 - 2. Supports viewing of event log on keypads.
- M. Features:
 - 1. Capable of being programmed locally or remotely.
 - 2. Supports panic/duress codes.
 - 3. Supports force arming.
 - 4. Supports cross zoning.

2.3 KEYPADS

- A. Manufacturer: Same as manufacturer of alarm control unit.
- B. Provides interface to alarm control unit for system control and remote annunciation.
- C. Provides visual notification of system status and zone information.
- D. Provides audible notification to indicate system status, entry/exit delay, and alarm situations; provide separate distinguishable sounds for alarm and trouble conditions.

- E. Keypad Type: Only LCD or graphic touch screen keypads are acceptable. Do not use LED keypads.
- F. Graphic Touch Screen Keypads: Displays system status and zone information using plain English on graphic display; touch screen interface.
- G. LCD Keypads: Displays system status and zone information using plain English on alphanumeric display; illuminated keys.
- H. Keypad Color: To be selected by Architect from manufacturer's available standard colors.

2.4 INITIATING DEVICES

- A. Manufacturers: Same as manufacturer of alarm control units where possible.
- B. General Requirements:
 - 1. Provide devices suitable for intended application and location to be installed.
 - 2. Outdoor Units: Weather resistant, suitable for outdoor use.
 - 3. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by control unit.
 - b. Provide suitable addressable modules for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
- C. Contacts:
 - 1. Listed and labeled as complying with UL 634.
 - 2. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors or windows.
 - a. Use standard security contacts (not balanced magnetic type) unless otherwise indicated.
- D. Motion Detectors:
 - 1. Listed and labeled as complying with UL 639.
 - 2. Passive Infrared (PIR) Motion Detectors: Designed to detect intruder by sensing movement of thermal energy between zones.
- E. Power Loss Sensors:
 - 1. Designed to activate upon detecting loss of power.

2.5 ALARM NOTIFICATION APPLIANCES

- A. Manufacturers: Same as manufacturer of alarm control units where possible.
- B. Provide alarm notification appliances suitable for connection to control unit outputs.
- C. Outdoor Units: Weather resistant, suitable for outdoor use.
- D. Sirens: Speaker with self-contained siren driver.

1. Provide tamper switches for outdoor units.

2.6 ACCESSORIES

- A. Provide components as indicated or as required for connection of alarm control unit to devices and other systems indicated.
- B. Provide cables as indicated or as required for connections between system components.
- C. Provide end-of-line resistors (EOLR) as required for supervision of hardwired zones.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
- 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. Install products in accordance with manufacturer's instructions.
- C. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
 1. Use listed plenum rated cables in spaces used for environmental air.
 2. Conceal all cables unless specifically indicated to be exposed.
- D. Provide grounding and bonding in accordance with Section 26 0526.
- E. Identify system wiring and components in accordance with Section 26 0553.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Prepare and start system in accordance with manufacturer's instructions.
- C. Inspection and testing to include, at a minimum:
 1. Test each initiating device for proper response by alarm control unit.

2. Test for proper operation of alarm notification appliances.
3. Test for proper operation of output relays.
4. Test for proper operation of communication interfaces and central station reporting.
5. Test for proper interface with other systems.

- D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.4 ADJUSTING

- A. Program system parameters according to requirements of Owner.

3.5 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of four hours of training.
 3. Instructor: Manufacturer's authorized representative.
 4. Location: At project site.

3.7 PROTECTION

- A. Protect installed system components from subsequent construction operations.

3.8 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION 283111

SECTION 284600 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Circuits from protected premises to supervising station, including conduit.
- D. Maintenance of fire alarm system under contract for specified warranty period.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping: Materials and methods for work to be performed by this installer.
- B. Section 08 3323 - Overhead Coiling Doors: Coiling fire doors to be released by fire alarm system.
- C. Section 08 7100 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- D. Section 14 2100 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.
- E. Section 14 2400 - Hydraulic Elevators: Elevator systems monitored and controlled by fire alarm system.
- F. Section 21 1300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- G. Section 21 3000 - Fire Pumps: Supervisory devices.
- H. Section 23 3300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.
- I. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems: Requirements for the seismic qualification of equipment specified in this section.

1.3 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.
- F. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Proposal Documents: Submit the following with cost/time proposal:
 - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
 - 3. Certification by Contractor that the system design will comply with Contract Documents.
 - 4. Proposed maintenance contract.
- C. Evidence of designer qualifications.
- D. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.

6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 9. Air-Sampling Smoke Detection Systems: Include air-sampling pipe network layout with sampling ports identified; include calculations demonstrating compliance with specified requirements.
 10. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 12. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 13. Certification by Contractor that the system design complies with Contract Documents.
- E. Manufacturer's equipment seismic qualification certification.
- F. Evidence of installer qualifications.
- G. Evidence of instructor qualifications; training lesson plan outline.
- H. Evidence of maintenance contractor qualifications, if different from installer.
- I. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- J. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.

8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- K. Project Record Documents: See Section 01 7800 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- L. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Certificate of Occupancy.
 4. Maintenance contract.
 5. Report on training results.
- M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 2. Furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory.
 - c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

- B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 - 4. Certified in the State in which the Project is located as fire alarm installer.
- C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 WARRANTY

- A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories - Basis of Design: Silent Knight.
- B. Fire Alarm Control Units and Accessories - Other Acceptable Manufacturers:
 - 1. Honeywell Security & Fire Solutions/Gamewell-FCI
 - 3. Edwards
 - 4. Notifier.
 - 5. Provide control units made by the same manufacturer.
- C. Manufacturers Not Acceptable: Simplex & Siemens.

D. Initiating Devices and Notification Appliances:

1. Same manufacturer as control units.

E. Substitutions: See Section 01 6000 - Product Requirements.

1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.2 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:

1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the local authority having jurisdiction.
 - c. Applicable local codes.
 - d. Contract Documents (drawings and specifications).
 - e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
7. Program notification zones and voice messages as directed by Owner.
8. Fire Alarm Control Unit: New, located at location indicated on drawings.
9. Combined Systems: Do not combine fire alarm system with other non-fire systems.

B. Supervising Stations and Fire Department Connections:

1. Public Fire Department Notification: By on-premises supervising station.
2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at _____.
3. Remote Supervising Station: UL-listed central station under contract to facility.

4. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), One telephone line and Internet connection..

C. Circuits:

1. Initiating Device Circuits (IDC): Class B, Style A.
2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
3. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Speaker Amplifiers: Minimum 25 percent spare capacity.
4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:

1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
4. Each Computer System: Provide uninterruptible power supply (UPS).

- F. Seismic Qualification: Provide fire alarm system and associated components suitable for application under the seismic design criteria specified in Section 26 0548 where required. Include certification of compliance with submittals.

2.3 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:

1. Sprinkler water control valves.
2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.
4. Fire pump(s).
5. Elevator shut-down control circuits.

- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:

1. Sprinkler water flow.
2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
4. Duct smoke detectors.

C. Elevators:

1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:

1. Duct Smoke Detectors: Close dampers indicated; shut down air handler associated Air-Handling Unit. Notify BAS System of specific Air-Handling Unit shutdown.

E. Doors:

1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 7100.
2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 7100.
3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 3323.

2.4 COMPONENTS

A. General:

1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Control Unit: As specified for Basis of Design above, or equivalent.

D. Remote Annunciators: Locate (1) in each Main Lobby (Total 2-annunciators).

E. Initiating Devices:

1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
2. Manual Pull Stations.
3. Smoke Detectors.
4. Duct Smoke Detectors. **Provide remote test station with every duct smoke detector. Where duct smoke detector is above ACT ceiling, mount test station in ceiling. For all other duct smoke detectors, provide remote test station on wall nearby. Coordinate all final locations with owner prior to roughing in (ADDENDUM #5)**
5. Heat Detectors.
6. Addressable Interface Devices: Provide Addressable interface devices required for monitoring dry contacts (Flow & Tamper Switches, Knox Box, etc.) and control relays to initiate action (Air-handling unit shutdown, Door release, Kitchen Shunt-trip for power units below hood, ect.) .

F. Notification Appliances:

1. Speakers.
2. Strobes.

G. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

H. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.

I. Locks and Keys: Deliver keys to Owner.

1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type

J. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.

1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.
- E. Perform system voice intelligibility testing for large spaces with sound reflective surfaces including but not limited to Gymnasiums, Cafeteria, LGI classrooms. Test in accordance to national guidelines, and provide system modifications (addition of speakers, adjustment of speaker taps, etc.) as required until results are within acceptable levels.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

- H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
1. Record all system operations and malfunctions.
 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.3 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
1. Hands-On Instruction: On-site, using operational system.
 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
 3. Factory Instruction: At control unit manufacturer's training facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
1. Initial Training: 1 session pre-closeout.
- D. Detailed Operation: Two-hour sessions for engineering staff; assume NICET level I qualifications or equivalent; combination of classroom and hands-on:
1. Initial Training: 1 session pre-closeout.
- E. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
1. Initial Training: One 3-day session, pre-closeout.
 2. Refresher Training: One 1-day session post-occupancy.
- F. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- G. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.

- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.
 - 4. All aspects of operation have been demonstrated to Owner.
 - 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 - 6. Occupancy permit has been granted.
 - 7. Specified pre-closeout instruction is complete.

- C. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.5 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 - 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 - 3. Record keeping required by NFPA 72 and authorities having jurisdiction.

- D. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 2 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

END OF SECTION 284600

THIS PAGE INTENTIONALLY LEFT BLANK

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 1221 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

1.6 SURVEY SUBMITTALS

- A. 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.

1.7 LOCAL BDA SERVICES

- A. Below is the contact information for a local BDA installer who has worked within the Township. This information is provided as a resource only. The Contractor is NOT required to use this installer for services.
1. Metropolitan Communications
309n Commerce Drive, Exton, Pa 19341
Office Number 610-363-5858
Contact Ron Simpson:
Email: rsimpson@mcsradiocom

END OF SECTION 285500

THIS PAGE INTENTIONALLY LEFT BLANK

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

- A. Section 312316 - Excavation: Building and foundation excavating.
- B. Section 312316.26 - Rock Removal: Removal of rock during excavating.
- C. Section 312323 - Fill: Backfilling at building and foundations.
- D. Section 334600 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.

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. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Compaction Density Test Reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.1 FILL MATERIALS

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.

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:

1. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.7 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

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.

END OF SECTION 312316.13

SECTION 337119 - ELECTRICAL UNDERGROUND DUCTS & TRANSFORMER VAULT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nonmetallic duct and ductbank.
- B. Transformer vault.

1.2 RELATED REQUIREMENTS

- A. Section 312316 - Excavation.
- B. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.
- C. 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 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for nonmetallic conduit and transformer vault 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 TRANSFORMER VAULT

- A. Description: Precast vault designed in accordance with ASTM C858, comprising modular, interlocking sections complete with accessories. Transformer vault must meet PECO requirements.
- B. Loading: ASTM C857, Class A-16.
- C. Shape: Square.
- D. Wall Thickness: 9 inches.
- E. Base Section: Include 3 inch deep x 14 inch round sump with cast sleeve, and two 1 inch ground rod openings.
- F. Duct Entry Provisions: Window knockouts.
- G. Cable Pulling Irons: Use galvanized rod and hardware. Locate opposite each duct entry. Provide watertight seal.

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 transformer vault 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. Coordinate with other trades and verify with utilities.
- E. Transformer vault location is shown in approximate location. Coordinate with PECO. 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.
- Q. Verify duct bank requirements with PPL prior to installation.

3.3 PRE-CAST TRANSFORMER VAULT INSTALLATION

- A. Excavate for transformer vault installation under the provisions of Section 312316.
- B. Install and seal precast sections in accordance with ASTM C891.
- C. Install transformer vault plumb.
- D. Backfill manhole excavation under the provisions of Section 312323.

END OF SECTION 337119

THIS PAGE INTENTIONALLY LEFT BLANK