PROJECT MANUAL

West Chester Area School District

BHA Nº: 22-114

Renovations & Additions to the Mary C. Howse Elementary School

641 Boot Road
West Chester, PA 19380

VOLUME 2
Facility Construction

ISSUED FOR BID SET
10/31/2023

150 S. Independence Mall West | Suite 1200 | Philadelphia, PA 19106 | P: 215.829.0922 | F: 215.829.0596 | www.blackneyhayes.com

DOCUMENT 000107 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:

1. Blackney Hayes Architects.
2. Darin Jellison.
3. License No. RA403157.
4. Responsible for Divisions 02-49 Sections except where indicated as prepared by other design professionals of record.

B. Civil Engineer:

1. Stantec Consulting Services.
2. Charles J. Olivo, PE.
3. License No. PE-26200E.
4. Responsible for Sections:

a. 024119.
b. 311000.
c. 312000.
d. 313200.
e. 315000.
f. 321216.
g. 321373.
h. 321600.
i. 329100.
j. 329200.
k. 329300.
l. 331000.
m. 333000.
n. 334100.

C. Structural Engineer:

1. Baker, Ingram & Associates.
2. Brian D. McGlade, PE
3. License No. 035277.
4. Responsible for the following Sections:

a. 031000.
b. 032000.
c. 033000.
d. 051200.
e. 053100.
f. 054000.

D. Fire-Protection Engineer:

1. Snyder Hoffman Associates, Inc.
2. Jeff Machik, PE.
3. PA – PE 083135.
4. Responsible for Sections in Division 21.

E. Plumbing Engineer:

1. Snyder Hoffman Associates, Inc.
2. Jeff Machik, PE.
3. PA – PE 083135
4. Responsible for Sections in Division 22.

F. HVAC Engineer:

1. Snyder Hoffman Associates, Inc.
2. Jeff Machik, PE.
3. PA – PE 083135.
4. Responsible for Sections in Division 23:

G. Electrical Engineer:

1. Snyder Hoffman Associates, Inc.
2. Jeff Machik, PE.
3. PA – PE 083135.
4. Responsible for Sections

a. In Division 26.
b. In Division 27.
c. In Division 28.
d. Section 312316.13.
e. Section 337119.

END OF DOCUMENT 000107

SECTION 000110 - TABLE OF CONTENTS

VOLUME 1 OF 2:

DIVISION 33 UTILITIES

END OF SECTION 000110

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 Fire Protection equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides fire protection equipment. See Div. 26 specifications for starters, combination starters, and switches.

B. Power wiring from panelboards or similar source through all equipment disconnects to motors or heating equipment shall be furnished and installed by the Electrical Contractor.

C. Equipment disconnect switches, unless otherwise specified or supplied by the equipment supplier as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.

D. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the electrical specifications.

E. All base flashing, where required, shall be by the Roofing Contractor, with necessary counter-flashing by this contractor.

F. All structural work needed for support of mechanical equipment or components shall be provided by this contractor unless shown on structural plans.

1.3 RULES AND REGULATIONS:

A. All work shall be performed in accordance with the rules and regulations of the ICC Codes, local plumbing code ordinances, NFPA Code, and the public utilities having jurisdiction.

B. All work shall be performed in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.

C. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.

D. The Owner will obtain the building permit. Any other fees relative to the contractor’s work shall be paid by the contractor as part of his bid.

E. Contractor's must be licensed within the Township which the project is located. Copies of these licenses must be posted within the respective job trailers during construction.

1.4 ANCHOR BOLTS:

A. Each Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished by him under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.

B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.

C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.5 DRAWINGS:

A. The accompanying drawings are a part of these specifications and are intended to show approximate and relative locations of services and equipment. They shall not be scaled to determine exact positions, locations and clearances.

B. Due to the diagrammatic layout and small scale of the drawings, certain piping, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.

C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to consult other trades, this Contractor shall rearrange his work at his own expense.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT AND MATERIALS

A. Refer to Division 1.

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

1.7 VISIT TO THE SITE:

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

1.8 COORDINATION OF WORK:

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

1.9 LOCATION OF EQUIPMENT:

A. All locations of fire protection equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.

B. This Contractor shall obtain Architect approval of all arrangement drawings before continuing his work.

1.10 MATERIALS AND EQUIPMENT:

A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.

B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation.

C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.11 WORKMANSHIP:

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

1.12 PROTECTION OF EQUIPMENT:

A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.

B. He shall schedule material and systems for deliver in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.

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

1.13 SCAFFOLDING AND HOISTING:

A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.

B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.14 FOREMAN:

A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.

B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.15 SLEEVES:

A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.

B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal.

C. Where sleeves pass through foundation walls, the space between such sleeves and passing pipes shall be caulked with graphite packing and an approved plastic and waterproof caulking compound as approved by the Architect. In lieu of caulking materials, Contractor has option of using preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.

D. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.

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

1.16 CONCRETE AND MASONRY WORK:

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

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

1.17 ESCUTCHEONS:

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

B. All exposed plumbing short branch connections to fixtures and/or equipment passing through wall or floors shall be equipped with pressed brass, chromium plated, solid-type escutcheons.

C. Provide angle collars at ducts where they pass through finished walls, floors and ceilings.

1.18 ACCESS DOORS AND PANELS:

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

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

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

1.19 CUTTING AND PATCHING:

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

B. If openings are omitted or are incorrect through failure of Contractor to follow these instructions, the Contractor shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Architect.

C. The Prime Contractor shall be responsible for the cutting of existing floor slabs for the installation/demolition of any underground piping systems required by the documents. The Prime Contractor is responsible for proper bedding, backfill materials and compaction (as outlined in the specifications and on the drawings) to an elevation that is level with the bottom of the existing concrete floor slab. The Prime Contractor is responsible for the patching of the floor slab, with proper materials which are equivalent to the adjacent finishes and materials. The new finished floor will be provided by the General Contractor.

D. Cutting and patching of exposed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All hole's cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.

E. Cutting and patching of concealed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All hole's cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.

F. Where it becomes necessary to cut out any portions of walls, floors, ceilings, roof or other portions of the building for the installation of work as may be required to perform and complete the work under this Contract, the Contractor shall do all necessary cutting and fitting, shall remove all excess material, and shall replace all work damaged so as to leave the entire premises in a finished condition. Refer to Contractor Responsibility Notes on Drawings.

G. No cutting shall be done which may in any way affect the building structurally or architecturally. Any damage incident to cutting or other causes in the performance of this Contract shall be made good by replacement or repairs. Cutting shall be done only with the prior approval of the Architect. Refer to Contractor Responsibility Notes on Drawings.

1.20 GUARANTEE:

A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of two years from date of acceptance by Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period. Compressors shall have an additional 4-year warranty.

B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.

C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

1.21 CLEANING OF SYSTEMS:

A. The Contractors shall thoroughly clean all pipe systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.

B. All strainers shall be opened and cleaned thoroughly.

C. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.22 INSTRUCTION TO EMPLOYEES:

A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance, and operation of equipment installed by him.

B. Three copies of factory maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.

C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.23 SUBSTITUTIONS:

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

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

1.24 ALTERNATES:

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

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

1.25 ALIGNMENT:

A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.

B. The Fire Protection Contractor shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS:

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

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

1.27 PAINTING:

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

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

END OF SECTION 210100

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fire Suppression system requirement for sprinkler systems.

B. Piping and Fittings

C. General Valves

1.2 RELATED REQUIREMENTS

A. Division 09 - Painting and Coating: Preparation and painting of fire protection piping systems.

B. Section 210553 - Identification for Fire Suppression Piping and Equipment: Piping Identification.

C. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.3 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).

B. ASME B16.5 - Pipe Flanges and Flanged Fittings; The American Society of Mechanical Engineers; 2003 (ANSI/ASME B16.5).

C. ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings; The American Society of Mechanical Engineers; 2007.

D. ASME B16.25 - Buttwelding Ends; The American Society of Mechanical Engineers; 2007.

E. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.

F. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2007.

G. ASTM A 795/A 795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2008.

H. AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm Through 1200 mm), for Water and Other Liquids; American Water Works Association; 2003.

I. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2007 (ANSI/AWWA C111/A21.11).

J. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002, and Errata 2002 (ANSI/AWWA C151/A21.51).

K. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2016.

L. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances; National Fire Protection Association; 1995.

M. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

N. UL 262 - Gate Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2004.

O. UL 312 - Check Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2004.

P. UL 1091 - Butterfly and Ball Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2005.

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturers catalogue information. Clearly indicate exact models/model number, options, and accessories to be provided. Indicate applications where the submitted product is to be used. Indicate design pressure and ratings.

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

D. Project Record Documents: Record actual "as installed" locations of piping, sprinklers, components, and tag numbering and submit as "Record Set" after completion of all installation work.

E. Operation and Maintenance Data: Include installation instructions and spare parts lists.

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

1. See Division 01 - Product Requirements, for additional provisions.
2. Extra Valve Stem Packings: Two for each type and size of valve.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

B. Installer and Designer Qualifications: Company specializing in performing the work of this section with minimum 5 year’s experience. approved by manufacturer.

C. Conform to UL requirements.

D. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

F. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.7 EXTRA MATERIALS

A. Provide cabinet, wrench, and spare sprinkler heads (quantities in accordance with NFPA13.)

B. Provide two valve stem packings for each size and type of valve installed.

PART 2 - PRODUCTS

2.1 FIRE SUPPRESSION SYSTEMS

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

2.2 ABOVE GROUND PIPING

A. Acceptable Manufacturers for Piping and Tubing:

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

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

C. Fittings:

1. All fittings shall be pressure rated for minimum 250 psig working pressure.
2. Welded Steel Fittings: ASME B16.9, wrought steel, buttwelded, ASTM A 234/A 234M, wrought carbon steel or alloy steel, or ASME B16.5, steel flanges and fittings. Welding Materials in accordance with ASME Code.
3. Threaded Malleable Iron Fittings: ASME B16.3, threaded fittings.

4. Mechanical Grooved Fittings as manufactured by Victaulic ONLY: ASTM A536 ductile iron or ASTM A53 carbon steel fittings with grooved ends designed to accept Victaulic couplings. FireLock® or standard fittings.
5. Mechanical Grooved Couplings as manufactured by Victaulic ONLY: Ductile iron housing clamps with tapered seat to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
   a. Saddle type - U-bolt style hole cut Mechanical -T's shall not be permitted for use on this project. Hole cut Mechanical-T's shall be Victaulic Style 920 or 920N and installed in strict accordance with manufacturer's instructions.
   b. Rigid Couplings: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.
      1) 1-1/4" to 4": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock® EZ Style 009.
      2) 5" and Larger: Standard rigid coupling. Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
   c. Flexible Couplings: Use in seismic areas where required by NFPA 13.
      1) 2" to 6": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic™.
      2) 8" and Larger: Standard flexible coupling. Victaulic Style 75 or 77.
      3) Coupling gaskets shall be listed for use as follows:
   d. Coupling gaskets shall be listed for use as follows:
      1) Dry System (Ambient Temperature) - FlushSeal® or EZ Style 009 design, Grade EPDM, Type A
      2) Dry Freezer Applications (-30°F to 0°F) - FlushSeal®, Grade L, Silicone
      3) Wet System (Ambient Temperature) - C-Shape or EZ Style 009 design, Grade EPDM, Type A
6. Flanged Adapters: ASTM A536 ductile iron casting, flat faced, designed for incorporating flanged components with ANSI Class 150 bolt-hole pattern. Victaulic Style 741.
7. Victaulic Aquaflex stainless steel sprinkler fitting system: In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic Aquaflex Multiple-use Flexible Stainless-Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless flexible tube, a zinc plated steel 1" male nipple for connection to branch line piping, and a zinc plated steel reducer with a ½" or ¾" female thread for connection to the sprinkler head.
   a. The drop shall include a UL-2443 approved and FM-1637 listed series AH2 braided hose with bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for (5) bends at 36" length, (7) bends at 48" length, (9) bends at 60" length and (10) bends at 72" length.
   b. Union joints shall be provided for ease of installation. The flexible drops shall attach to the ceiling grid using a one-piece open grate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed and FM approved for sprinkler services to 175psi.
      a. All hoses shall be factory pressure tested to 400psi
      b. Approvals
         i. FM-1637
         ii. UL-2443

c. Refer to the Victaulic I-AQUAFLEX installation manual and the Victaulic Aquaflex Design guide, as shown in product submittal to ensure proper installation.
d. Contractor, upon completion of sprinkler system, shall provide the Owner/ Architect/Engineer with a letter from the flexible drop manufacturer stating that the installation has been inspected and approved.

2.3 PIPE HANGERS AND SUPPORTS

A. Acceptable Manufacturers for Piping Hangers and supports:

1. TOLCO Inc.
2. Grinnell
3. Provide hangers and supports as manufactured by the listed acceptable manufacturers or equal as approved by owner/architect.

B. Hangers for Pipe Sizes ¾ inches thru 1½ inches: Adjustable swivel ring, MSS-SP-69 Type 10, Carbon steel, or Adjustable Clevis, MSS-SP-69 Type 1, Carbon steel.

1. Adjustable swivel ring: TOLCO Inc. - Fig.200 or equal.
2. Adjustable clevis: TOLCO Inc. - Fig.1 or equal.
   a. Provide bolt spacer in all applications where seismic restraint is required.

C. Hangers for Pipe Sizes 2 inches and Over: Adjustable Clevis, MSS-SP-69 Type 1, Carbon steel.

1. Adjustable Clevis: TOLCO Inc. - Fig.1 or equal.
   a. Provide bolt spacer in all applications where seismic restraint is required.

D. Armovers and end of branch: Adjustable swivel ring with surge restrainer, MSS-SP-69 Type 10, or carbon steel adjustable clevis, MSS-SP-69 Type 1.

1. Adjustable swivel ring: TOLCO Inc. - Fig.200 or equal w/ Fig.25 surge Restrainer
2. Adjustable clevis: TOLCO Inc. - Fig.1 or equal.

E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

F. Wall Support: Welded steel bracket and wrought steel clamp.

G. Vertical Support: Steel riser clamp, MSS-SP-69 Type 8.

1. Steel Riser Clamp: TOLCO Inc. - Fig.6 or equal.

H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

I. Structural Attachments

1. Reversible C-Type Beam Clamp, MSS-SP Type 19 - TOLCO Inc. Fig. 65 & Fig. 66 with Beam clamp retaining strap or equal as approved by Owner/Architect.
2. Bar Joist Hanger, TOLCO Inc. Fig. 61T (up to 4" pipe)
3. Threaded side Beam Bracket, TOLCO Inc. Fig. 58 (up to 4" pipe)

4. Provide additional steel to support work from structural framing members as required where support is required between framing members.

J. Victaulic Style 009, 005, and 07 rigid couplings, with angle-pattern bolt pads, may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA 13. An adequate number of Victaulic Style 177, 75 and 77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

2.4 GATE VALVES

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

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

2.5 GLOBE OR ANGLE VALVES

A. Up to and including 2 inches:

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

B. Over 2 inches:

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

2.6 BALL VALVES

A. Up to and including 2 inches:

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

B. Over 2 inches:

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

2.7 BUTTERFLY VALVES

A. Bronze Body (up to 2 inches):

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

B. Ductile Iron Body (up to 4 inches)

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

2.8 CHECK VALVES

A. 2 inches to 3 inches:

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

B. 4 inch to 12 inches:

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

2.9 DRAIN VALVES

A. Ball Valve:

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

2.10 SLEEVES:

A. Sleeves through foundation walls shall be preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.

B. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe.

C. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal.

D. Unless otherwise specified or shown, sleeves shall be two pipe sizes larger than the overall outside diameter of the pipe when insulated.

2.11 ESCUTCHEONS:

A. Solid pattern, heavy ceiling floor or wall escutcheons. Steel or Malleable iron with set screw. Prime coated ready for painting.

B. Pressed brass, chromium plated, solid-type escutcheons.

2.12 ACCESS DOORS AND PANELS:

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

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

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

2.13 ANCHOR BOLTS:

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13 and the additional requirements below.

1. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
2. Place hangers within 12 inches of each horizontal elbow.
3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
4. Support vertical piping at every other floor. Provide one riser support on each floor where grooved piping is used. Support riser piping independently of connected horizontal piping.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Provide additional supports as follows:
   a. Provide minimum of two hangers on any grooved piping exceeding 11ft. in length.
   b. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.

1) Do not fasten or anchor work to concrete deck except where individually approved by Structural Engineer and Architect.
2) Do not fasten or anchor any work directly to metal roof deck.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and work of other trades.

D. Group piping whenever practical at common elevations.

E. Provide sleeves when penetrating footings, floors, and walls and fill annular space between piping and sleeves.

1. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
2. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material and the sleeve shall be of a material as required to achieve fire resistance equivalent to fire separation required.

F. Provide escutcheons on all exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces. Escutcheons will not be required where sleeves intentionally extend above finished floor.

G. Install valves, specialties, and other serviceable items within accessible spaces. Provide access panels where valves, specialties, and other serviceable items are required to be installed behind plaster, tile, or similar type non-removable surfaces. Coordinate panel installation with G.C. in field.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Perform welding in accordance with ASME Code.

J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Division 9 for painting requirements.

L. Do not penetrate building structural members unless indicated.

M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

N. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.

O. Provide OS&Y gate or butterfly valves for shut-off or isolating service.

P. Provide drain valves at main shut-off valves, low points of piping and apparatus.

Q. Provide all concrete bases, reinforcing, etc. required to install the work of this section, unless otherwise noted. Prior to installing any forms, reinforcing or concrete, notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete.

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

END OF SECTION 210500

SECTION 210553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

A. See Division 01.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Provide Zone valve drawing (to indicate what area is served by valve) and post at each valve.

F. Project Record Documents: Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Brady Corporation: www.bradycorp.com.

B. Champion America, Inc: www.Champion-America.com.

C. Seton Identification Products: www.seton.com/aec.

D. Substitutions: See Division 01.

2.2 NAMEPLATES

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

2.3 TAGS

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

B. Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

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

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

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

2.5 PIPE MARKERS

A. Color: Conform to ASME A13.1.

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

2.6 CEILING TACKS

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

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

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Division 09.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Provide additional labeling for location of equipment and valving as required by the Authority Having Jurisdiction. Coordinate work with Architect in field.

F. Identify pumps and valves with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

G. Identify valves in main and branch piping with tags. Provide As-Built drawings identifying tag# and location of all valves.

H. Tag automatic controls, instruments, and relays. Key to control schematic.

I. Identify piping 2" and smaller, concealed or exposed, with plastic pipe markers. Identify piping 2-1/2" and larger, concealed or exposed, with stencils. Verify requirements for piping identification in finished areas with exposed piping with Architect in field. Identify all piping within Boiler Rooms with stencils. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification on horizontal piping not to exceed 20 feet on straight runs and at each side of penetration of structure or enclosure. Locate additional identification on risers and drops, adjacent to each Tee of main piping, and at each obstruction.

END OF SECTION 210553

SECTION 211300 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. System design, installation, and certification.

C. Sprinkler Alarm Valves

D. Supervisory and Monitoring Devices

E. Sprinkler System Accessories and Equipment

1.2 RELATED REQUIREMENTS

A. Section 21 0500 - Common Work Results for Fire Suppression.

B. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.

C. Section 26 2726 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

B. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2016.

C. 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\Engineer.

D. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

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

1. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
2. Sprinkler Wrenches: For each sprinkler type.

H. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.5 QUALITY ASSURANCE

A. Maintain one copy of referenced design and installation standard on site.

B. Conform to UL requirements.

C. Designer Qualifications: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

E. Installer and Designer Qualifications: Company specializing in performing the work of this section with working knowledge of NFPA13 installation requirements with minimum 5 years' experience with fire protection systems similar to that required by this project. The

F. Equipment and Components: Provide products that bear UL label or marking.

G. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

H. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

I. To assure uniformity and compatibility of sprinklers within the fire protection system, all sprinkler heads shall be supplied by a single manufacturer.

J. To assure uniformity and compatibility of piping specialties within the Fire Protection system, all products within each of the product families specified below shall be supplied by a single manufacturer.

1.6 PRE-INSTALLATION MEETING

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 TESTING

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

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

1.9 EXTRA MATERIALS

A. Provide extra sprinklers of type and size matching those installed, in quantity required by referenced NFPA design and installation standard.

B. Provide suitable wrenches for each sprinkler type.

C. Provide metal storage cabinet for spare sprinklers adjacent to main service entrance. Verify exact location with Owner Representative in field.

PART 2 - PRODUCTS

2.1 SPRINKLER SYSTEM

A. Provide a "design build" Fire Suppression Sprinkler System in accordance with IBC 2018 and NFPA 13 (2016 edition), and inclusive of all additional requirements as indicated on the drawings and in these specifications. The entire building shall be "sprinkled throughout" with "Quick Response" standard coverage sprinklers. No Extended coverage heads shall be permitted except where specifically noted on the Fire Protection drawings. All new and renovated building areas shall be provided with new sprinklers and system as noted on the FP series drawings. The entire Fire Suppression System shall be hydraulically calculated to provide the prescribed density uniformly over the most remote area in accordance with NFPA 13.

1. Occupancy: Building predominantly Light Hazard, some areas of other classification in accordance with NFPA 13 and document drawings.
2. Water Supply: Contractor shall provide flow test for use in hydraulically calculating the sprinkler system.

B. Interface system with building control system.

C. Provide Hose Connections/Hose Connection Valves where indicated on the FP drawings.

D. 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.

B. Submit water flow test data with Hydraulic Calculations.

C. Existing Flow Test Data as Follows:

Static Pressure: 80 PSI.
Residual Pressure: 40 PSI
Flow: 1034 GPM
Location of Test: Boot Road & Sonnet Lane.

2.3 SPRINKLER HEADS AND ACCESSORIES

A. Acceptable Manufacturers

1. All sprinkler heads shall be provided by from a single manufacturer.
2. Viking Corporation.
3. Victaulic.
4. Tyco.

B. Suspended Ceiling Type (ACT and GWB): Quick Response, Concealed pendant type with matching push on escutcheon plate.

1. Finish: Brass.
2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
4. Design Basis: Victaulic Model V38 series (Quick Response).

C. Exposed Area Type: Quick Response, Standard upright or pendent type with chrome guard.

1. Finish: Brass.
2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
3. Design Basis: Victaulic Model V27 series (Quick Response).

D. Sidewall Type: Quick Response, Semi-recessed horizontal sidewall type with matching push on escutcheon plate.

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

E. Guards: Finish chrome.

2.4 FLOOR ZONE CONTROL MANIFOLD ASSEMBLY

A. Acceptable Manufacturers

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

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

1. Design Basis: Victaulic FireLock® Series 747M

2.5 WATER FLOW SWITCH

A. Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

1. ACCEPTABLE MANUFACTURERS
   a. All flow, pressure and supervisory switches shall be provided by a single manufacturer.
   b. Potter Roemer.
   c. System Sensor.

2.6 SUPERVISORY SWITCH

A. OSY type supervisory switch, with two contacts; rated 15 amp at 125 volt AC and 2.5 amp at 30 volt DC.

1. ACCEPTABLE MANUFACTURERS
   a. All flow, pressure and supervisory switches shall be provided by a single manufacturer.
   b. Potter Roemer.
   c. System Sensor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fire suppression system in accordance with all referenced standards and local codes.

B. Install equipment in accordance with manufacturer's instructions.

C. Place pipe runs to minimize obstruction to other work.

D. Place piping in concealed spaces above finished ceilings.

E. Center sprinklers within ACT ceilings in two directions relative to scoring and grid patterns as noted on approved architectural reflected ceiling plans. Refer to Fire Protection Details on contract drawings for additional information on centering of sprinklers within various ceiling types and patterns.

F. Align sprinklers symmetrically with other ceiling fixtures and elements as shown on approved architectural reflected ceiling plans.

G. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

H. Flush entire piping system of foreign matter.

I. Install guards on all exposed sprinklers except where noted otherwise.

J. Hydrostatically test entire system.

K. Require test be witnessed by Fire Marshal and authority having jurisdiction.

L. Provide system training for Owner representatives to include required maintenance, system supervisory devices, operating equipment, etc.

3.2 INTERFACE WITH OTHER PRODUCTS

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

3.3 SCHEDULES

A. System Hazard Areas:

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

END OF SECTION 211300

SECTION 220100 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 FIRE UNDERWRITER SEAL:

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

1.2 DEFINITION OF WORK RESPONSIBILITY:

A. All electrical control components including starters required for operation of plumbing equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides the plumbing equipment. See Division 26 specifications for starters, combination starters, and switches.

B. Power wiring from panel boards or similar source through all equipment disconnects to motors or heating equipment shall be furnished and installed by the Electrical Contractor.

C. Equipment disconnect switches, unless otherwise specified or supplied by the equipment supplier as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.

D. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the Division 26 electrical specifications.

E. All base flashing, where required, shall be by the Roofing Contractor, with necessary counter-flashing by this contractor. Flashing shall comply with the requirements of Division 07.

F. All structural work needed for support of mechanical equipment or components shall be provided by this contractor unless shown on structural plans.

1.3 RULES AND REGULATIONS:

A. Contractor shall be licensed by the Municipality/Township in which the work is performed. Contractor is responsible for meeting all licensing requirements of the Municipality and securing all necessary certifications prior to beginning work.

B. All work shall be performed in accordance with the rules and regulations of the ICC Codes, local plumbing codes, the utilities having jurisdiction, and the NFPA Code.

C. All work shall be performed in accordance with the rules and regulations or Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.

D. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.

E. The Owner will obtain the building permit. Any other fees relative to the contractor's work shall be paid by the contractor as part of his bid.

F. Contractor must be licensed within the Township which the project is located. Copies of these licenses must be posted within the respective job trailers during construction.

1.4 ANCHOR BOLTS:

A. Each Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished by him under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.

B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.

C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.5 DRAWINGS:

A. The accompanying drawings are a part of these specifications and are intended to show approximate and relative locations of services and equipment. They shall not be scaled to determine exact positions, locations and clearances.

B. Due to the diagrammatic layout and small scale of the drawings, certain piping rises, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.

C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical and other work shall be carefully examined. All work shall be coordinated prior to installation. Where physical interferences with his work occur because of his failure to coordinate with other trades, this Contractor shall rearrange his work at his own expense.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT AND MATERIALS

A. Refer to Division 1 for additional submittal requirements.

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

1.7 VISIT TO THE SITE:

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

1.8 COORDINATION OF WORK:

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

1.9 LOCATION OF EQUIPMENT:

A. All locations of plumbing equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.

B. The Mechanical Contractor shall prepare dimensioned coordination/arrangement drawings at a scale of (1/4" =1'0"). Layouts represented by these drawings shall be coordinated with all other trades.

C. This Contractor shall obtain Architect approval of all arrangement drawings before continuing his work.

1.10 MATERIALS AND EQUIPMENT:

A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.

B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation.

C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.11 WORKMANSHIP:

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

1.12 PROTECTION OF EQUIPMENT:

A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.

B. He shall schedule material and systems for deliver in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.

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

1.13 SCAFFOLDING AND HOISTING:

A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.

B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.14 FOREMAN:

A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.

B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.15 SLEEVES:

A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.

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

C. Where sleeves pass through foundation walls, the space between such sleeves and passing pipes shall be caulked with graphite packing and an approved plastic and waterproof caulking compound as approved by the Architect. In lieu of caulking materials, Contractor has option of using preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.

D. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.

E. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material. Refer to Division 1 specifications for fireproofing requirements.

1.16 CONCRETE AND MASONRY WORK:

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

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

1.17 ESCUTCHEONS:

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

B. All exposed plumbing short branch connections to fixtures and/or equipment passing through wall or floors shall be equipped with pressed brass, chromium plated, solid-type escutcheons.

C. Provide angle collars at ducts where they pass through finished walls, floors and ceilings.

1.18 ACCESS DOORS AND PANELS:

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

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

1.19 CUTTING AND PATCHING:

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

B. If openings are omitted or are incorrect through failure of the prime Contractors to coordinate the required openings, the respective Contractors shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Architect.

C. The Prime Contractor shall be responsible for the cutting of existing floor slabs for the installation/demolition of any underground piping systems required by the documents. The Prime Contractor is responsible for proper bedding, backfill materials and compaction (as outlined in the specifications and on the drawings) to an elevation that is level with the bottom of the existing concrete floor slab. Refer to Contractor Responsibility Notes on Drawings.

D. Cutting and patching of exposed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All holes cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.

E. Cutting and patching of concealed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All holes cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials. Refer to Contractor Responsibility Notes on Drawings.

F. Where it becomes necessary to cut out any portions of walls, floors, ceilings, roof or other portions of the building for the installation of work, and as may be required to perform and complete the work under this Contract, the Contractor shall do all necessary cutting and fitting, shall remove all excess material, and shall replace all work damaged so as to leave the entire premises in a finished condition.

G. No cutting shall be done which may in any way affect the building structurally or architecturally. Any damage incident to cutting or other causes in the performance of this Contract shall be made good by replacement or repairs. Cutting shall be done only with the prior approval of the Architect.

1.20 GUARANTEE:

A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of two years from date of acceptance by Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period. Compressors shall have an additional 4-year warranty.

B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.

C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

1.21 CLEANING OF SYSTEMS:

A. Contractor shall thoroughly clean all pipe systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.

B. All strainers shall be opened and cleaned thoroughly.

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

D. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.22 INSTRUCTION TO EMPLOYEES:

A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.

B. Three copies of factory maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.

C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.23 SUBSTITUTIONS:

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

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

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

1.24 ALTERNATES:

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

1.25 ALIGNMENT:

A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.

B. Contractor shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS:

A. Refer to Division 01 "Close-out Procedures" as well as the following.

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

C. The Contractor shall submit 1 of the hard-bound volumes to the Architect for approval prior to presenting same to Owner.

D. The purpose of this manual is to assist the Owner in routine operation, maintenance, servicing, troubleshooting and procurement of replacement parts. All information in the manual shall be as-built and only material pertinent to the project shall be included.

E. The operating manual shall be considered a part of the final inspection and shall be submitted for approval at least 30 days in advance of a request for final inspection. The manual shall include:

1. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.
2. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and troubleshooting techniques.
3. A listing of all items of mechanical and electrical equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.
4. Copies of all A.S.M.E. pressure vessel certifications, state police approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.
5. All of the materials shall be indexed, arranged categorically and be bound in a rigid, plastic covered, three ring binder.

F. The Contractor shall provide Project Record (As-Builts) documents in accordance with requirements of Division 1.

G. O & M manuals must be provided prior to equipment being turned over to the Owner.

H. Warranty period shall begin after date of substantial completion.

1.27 PAINTING:

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

B. Provide corrosion inhibiting prime coating on all ferrous materials.

C. Paint all metal laid underground with one heavy coat of corrosion protective materials.

D. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted 1 prime coat and 2 coats of best quality oil paint of color as selected by the Architect.

E. All exposed gas piping within boiler rooms and mechanical rooms shall be painted yellow and identified as required in Division 22 specifications.

F. Unless specifically noted, insulation and galvanized piping in ceiling cavity area shall not be painted.

G. Painting of piping within exposed finished areas shall be by the G.C. Installation of piping by the prime contractor shall include cleaning, degreasing, and preparation of piping for final painting by G.C.

1.28 EARTHWORK:

A. Refer to Division 31 as well as the following.

B. Provide all excavating, backfilling, shoring, sheeting, pumping, bailing, etc., required for the installation of the work of this Section.

C. Trench depths shall allow adequate cover over piping, walls shall be vertical and bottoms shall be instrument graded. Earth shall be scooped out under pipe hubs to provide a solid bearing for the barrel of the pipe on undisturbed earth. Concrete or other approved supports shall be provided for all pipes installed in fill.

D. Carry pipe trenches in rock below the pipe invert at least 1/4 the nominal diameter of the pipe or a minimum of 4" below the bottom of the pipe whichever is the greater. Backfill space below pipe with crushed stone or gravel ranging in size from 1/4" to 3/4".

E. Excavation under footings or foundations and deeper than the angle of repose from footings or foundations as determined by the Architect shall be backfilled solidly with 3,000-pound concrete, to such angle of repose and bottom of such footing or foundation. Where excavation damages existing lawns, sidewalks, roadways etc., such surfaces shall be restored to their original condition by the Contractor performing the excavation.

F. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.

G. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.

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

END OF SECTION 220100

SECTION 220501 - DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION OF WORK:

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

1.3 GENERAL:

A. Existing piping, fixtures, equipment, and related accessories which require systems to be shut-down shall be coordinated with the Owner. Periods of shut-down shall be minimal and all new work shall be planned and scheduled to accomplish as few shut-downs as possible.

B. All construction and removal work shall be performed in a manner as to keep the existing systems in operation as the work progresses. Prior to commencing construction, the contractor shall review the construction schedule with the Owner and Architect to assure a well coordinated schedule.

C. Remove as indicated on the drawings or as required existing waste, vent, water, gas, and storm water piping. Cap ends of piping which remain active.

D. Cutting and patching shall be by this Contractor unless otherwise indicated. Refer to Contractor Responsibility Notes on Drawings.

E. Remove or disconnect and cap existing piping (as indicated on the drawings) serving plumbing fixtures which are being removed.

F. The Owner shall have the option of keeping any or all salvageable items removed from building such as draft barriers, unit ventilators, cabinet heaters plumbing fixtures, etc. Any items removed from the building that Owner does not wish to keep shall become the property of this Contractor and he shall dispose of these items.

END OF SECTION 220501

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single phase electric motors.

B. Three phase electric motors.

1.2 SUBMITTALS

A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

D. Operation Data: Include instructions for safe operating procedures.

E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.3 QUALITY ASSURANCE

A. Conform to NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Manufacturers:

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

B. Construction:

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

C. Provide motors with phase loss protection.

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

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

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

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

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

I. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

J. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

K. Wiring Terminations:

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

2.2 MOTOR CONTROLLERS

A. Contractor shall provide motor controllers. The items shall be products of one manufacturer, Allen-Bradley, Square D, General Electric or Westinghouse, and shall meet latest N.E.M.A. and IEEE Specifications. Starters and contactors shall be horsepower rated. Starters shall include the proper size heater elements

B. Magnetic starters used with pressure or float switches, thermostats or similar maintained contact switches shall be provided with "On-Off-Auto" switches on the starter.

C. Unless otherwise noted, control and pilot devices such as electric thermostats, alternators, float controls, aqua stats, etc., shall be furnished and installed by the Mechanical Contractor. Each device shall be provided with all auxiliary features and accessories which may be required for correct operation of the associated equipment.

D. Magnetic starters shall be provided with start-stop pushbuttons on the starters unless remote control pushbuttons or other methods of starting are specified elsewhere.

E. Unless otherwise noted elsewhere, all magnetic motor starters controlled with a remote pilot device shall contain a control circuit transformer, as an integral part of the controller, providing control power at a maximum 120 volts for the pilot device. The exact control circuit voltage shall be coordinated with the ATC supplier prior to the purchase of any motor controllers.

F. Starters and protective devices which are provided as an integral part of the equipment furnished under the Mechanical Contracts, shall be supplied.

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

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

2.3 MOTOR DISCONNECTS:

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

2.4 ENCLOSURES:

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

2.5 MOTOR CONTROL WIRING:

A. The Electrical Contractor shall run the power wiring system from the various supply panels indicated, to the motors and motor controllers and shall make final connections unless otherwise noted on the Drawings. Contractor shall run all control wiring from the motor controllers to the pilot devices.

B. Starters, and protective control devices which are provided as integral part of the motors or motor-operated equipment shall be prewired at the factory.

C. After final connections are completed, Contractor shall test each motor for proper rotation. Before applying current to the motor, Contractor shall check the motor for alignment, oil, etc. Contractor shall make any necessary adjustments to the starter and control equipment for proper starting and overload protection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF DOCUMENT 220513

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Flexible pipe connectors.

B. Expansion joints and compensators.

C. Pipe loops, offsets, and swing joints.

D. RELATED REQUIREMENTS

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

E. REFERENCE STANDARDS

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

1.2 SUBMITTALS

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

B. Product Data:

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

1.3 REGULATORY REQUIREMENTS

A. Conform to UL requirements.

1.4 EXTRA MATERIALS

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

B. Supply two sets of packing for each packed expansion joint.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturers:

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

B. Construction

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

C. Application: Domestic Water - Copper piping.

2.2 EXPANSION JOINTS - TWO-PLY BRONZE BELLOWS TYPE

A. Manufacturers:

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

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

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

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

E. Maximum Extension: 1/4 inch.

F. Joint: Soldered.

G. Size: Use pipe sized units.

H. Application: Copper piping.

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

A. Manufacturers:

1. Mercer Rubber Company: www.mercer-rubber.com.
2. Metraflex Company: www.metraflex.com.

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

B. Working Pressure: 75 psi.

C. Maximum Temperatures: 250 degrees F.

D. Maximum Compression: 1/2 inch.

E. Maximum Extension: 5/32 inch.

F. Joint: Soldered.

G. Size: Use pipe sized units.

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

2.4 ACCESSORIES

A. Pipe Alignment Guides:

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

B. Swivel Joints:

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

1. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
2. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
3. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
4. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
5. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION 220516

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure gages and pressure gage taps.

B. Thermometers and thermometer wells.

1.2 RELATED REQUIREMENTS

A. Section 22 0100 - General Provisions

1.3 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2005.

B. ASTM E 1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2007.

C. ASTM E 77 - Standard Test Method for Inspection and Verification of Thermometers; 2007.

D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Underwriters Laboratories Inc.; 2005.

1.4 SUBMITTALS

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

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

C. Project Record Documents: Record actual locations of components and instrumentation.

1.5 FIELD CONDITIONS

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

1.6 EXTRA MATERIALS

A. See Division 01 - Product Requirements. for additional provisions.

B. Supply two bottles of red gage oil for static pressure gages.

C. Supply two dial thermometers.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:
1. American Granby Inc.: www.americangranby.com
2. Trerice, Inc.: www.trerice.com
3. Weskler: weskler-gauges.com
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Cast aluminum with phosphor bronze bourdon tube.
2. Size: 4-1/2-inch diameter.
3. Size: 2-inch diameter.
4. Mid-Scale Accuracy: One percent.
5. Scale: Psi.

2.2 PRESSURE GAGE TAPPINGS

A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.

B. Needle Valve: Brass, 1/4-inch NPT for minimum 150 psi.

C. Pressure Snubber: Brass with ss screen, and pigtail

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. American Granby Inc.: www.americangranby.com
2. Trerice, Inc.: www.trerice.com
3. Weskler: weskler-gauges.com
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Thermometers - Adjustable Angle: Red- appearing non-toxic liquid in glass; ASTM E 1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

1. Size: 9-inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4-inch NPT brass.
4. Accuracy: 2 percent, per ASTM E 77.
5. Calibration: Degrees F.

2.4 TEST PLUGS

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide pressure gauges before strainers and on suction and discharge of each pump.

C. Provide pressure gauge and thermometer on outlet of each water heater.

D. Provide pressure gauge at each water service entrance.

E. Provide pressure gauges and thermometer at all recirculation pump installations and as detailed on the plumbing drawings.

F. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical, and in accordance with manufacturers recommendations.

I. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

J. Locate test plugs adjacent thermometers and thermometer sockets.

K. Provide pressure gauges on inlet and outlet side of every backflow preventer on the project.

3.2 SCHEDULES

A. Pressure Gages, Location and Scale Range:

1. Domestic Water Pumps, 0 to 100 psi.
2. Sprinkler system, 0 to 250 psi.
3. Backflow preventers, 0 to 100 psi.

B. Pressure Gage Tappings, Location:

1. Balancing Control valves 3/4 inch & larger - inlets and outlets.

C. Stem Type Thermometers, Location and Scale Range:

1. Domestic hot water supply and recirculation, 0 to 200 degrees F.

D. Thermometer Sockets, Location:

1. Control valves 1 inch & larger - inlets and outlets.

END OF SECTION 220519

SECTION 220548 - VIBRATION AND ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Inertia bases.

B. Vibration isolators.

1.2 SUBMITTALS

A. Comply with pertinent provisions of Division 01.

B. Product Data: Provide schedule of vibration isolator type with location and load on each.

C. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

D. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.3 QUALITY ASSURANCE

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

B. Except as otherwise indicated obtain support isolation units from a single manufacturer.

C. Engage the manufacturer to provide technical supervision of the installation of support isolation units produced by him, and of associated inertia bases.

D. Manufacturer: Provide vibration isolation units manufactured by the following:

1. Isolation Technology, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

E. After installation is complete and while the system is operating, the vibration isolation Manufacturer and/or his qualified Representative shall conduct an inspection of the installation with the Contractor. The Representative will submit a written inspection report detailing any discrepancies, the Representative shall submit a report so stating. If there are discrepancies, the report shall detail corrective work to be done.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Isolation Technology, Inc: www.isolationtech.com.

B. Kinetics Noise Control, Inc: www.kineticsnoise.com.

C. Mason Industries: www.mason-ind.com.

D. Substitutions: See Division 01 - Product Requirements.

2.2 INERTIA BASES

A. Structural Bases:

1. Construction: Welded structural steel with gusseted brackets, to support equipment and motor, with motor slide rails.
2. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.

B. Concrete Inertia Bases:

1. Construction: Structural steel channel perimeter frame, with gusseted brackets and anchor bolts, reinforcing; concrete filled.
2. Mass: Minimum of 1.5 times weight of isolated equipment.
3. Connecting Point: Reinforced to connect isolators and snubbers to base.
4. Concrete: Minimum 3000 psi concrete.

2.3 VIBRATION ISOLATORS

A. Open Spring Isolators:

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

B. Restrained Open Spring Isolators:

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

C. Closed Spring Isolators:

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

D. Restrained Closed Spring Isolators:

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

E. Spring Hanger:

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

F. Neoprene Pad Isolators:

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

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

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Bases:

1. Set steel bases for one-inch clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
3. Adjust equipment level.

C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

E. Support piping connections to equipment mounted on isolators using isolators or resilient hangers to nearest flexible pipe connector.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.2 REFERENCE STANDARDS

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

1.3 SUBMITTALS

A. Labeling List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

E. Project Record Documents: Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Piping: Tags.

B. Pumps: Nameplates.

C. Small-sized Equipment: Tags.

D. Tanks: Nameplates.

E. Valves: Tags and ceiling tacks where located above lay-in ceiling.

F. Water Treatment Devices: Nameplates.

2.2 GENERAL

A. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or schedule. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: (Standpipe F12)

C. Manufacturers

1. Brady Corporation: www.bradycorp.com.
2. Champion America, Inc: www.Champion-America.com.
3. Seton Identification Products: www.seton.com/aec.
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

2.3 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.

1. Letter Color: White.
2. Letter Height: 1/4 inch.
3. Background Color: Black.

2.4 VALVE TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black piping system abbreviation (1/4" high lettering) and sequenced valve numbers (1/2" high lettering), light contrasting background color and with 5/32" hole for fastener. Tag size minimum 1-1/2-inch diameter.

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

C. Valve Schedule: Provide valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

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

2.5 STENCILS

A. Manufacturers:

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

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

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

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

2.6 PIPE MARKERS

A. Manufacturers:

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

B. Comply with ASME A13.1.

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

1. All Piping: Provide snap-on application of pre-tensioned semi-rigid plastic full-bank pipe markers, extending 360 degrees around pipe at each location.
2. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
3. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastics.

2.7 UNDERGROUND PLASTIC PIPE MARKERS:

A. Color code as follows:

1. Combustible Fluids: Brown with white letters.

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

2.8 CEILING TACKS

A. Manufacturers:

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

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

C Color code as follows:

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

PART 3 - EXECUTION

3.1 PREPARATION

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

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

3.2 INSTALLATION

A. Piping System Identification:

1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow:
2. Provide stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
3. Identify piping 2" and smaller, concealed or exposed, with plastic pipe markers. Identify piping 2-1/2" and larger, concealed or exposed, with stencils. Verify requirements for piping identification in finished areas with exposed piping with Architect in field. Identify all piping within Boiler Rooms with stencils.

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

B. Valve Identification:

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

C. Mechanical Equipment Identification:

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

D. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

E. Install tags with corrosion resistant chain.

F. Apply stencil painting in accordance with Division 09.

G. Install plastic pipe markers in accordance with manufacturer's instructions.

H. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

I. Use tags on piping 3/4-inch diameter and smaller.

1. Identify service, flow direction, and pressure.
2. Install in clear view and align with axis of piping.
3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

J. Identify valves in main and branch piping with tags.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

1.2 RELATED SECTIONS

A. Division 07 - Firestopping.

B. Division 09 - Painting and Coating: Painting insulation jacket.

C. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.3 REFERENCES

A. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2004.

B. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2005.

C. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation; 2006.

D. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2003.

E. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2003.

F. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.

G. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.

H. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

1.4 SUBMITTALS

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

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum THREE years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

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

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

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

2.2 GLASS FIBER

A. Manufacturers:

1. Knauf Fiber Glass: www.knaufusa.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.
5. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible.

1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
2. Maximum service temperature: 850 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.
4. Insulation: ASTM C 547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
   a. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
   b. Maximum service temperature: 650 degrees F.
   c. Maximum moisture absorption: 0.2 percent by volume.
5. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.
6. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12-inch centers.
7. Vapor Barrier Lap Adhesive:
   a. Compatible with insulation.

8. Insulating Cement/Mastic:
   a. ASTM C 195; hydraulic setting on mineral wool.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

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

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

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

2.4 JACKETS

A. PVC Plastic.

1. Manufacturers:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
   e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.
2. Jacket: One-piece molded type fitting covers and sheet material, off-white color.
3. Minimum Service Temperature: 0 degrees F.
4. Maximum Service Temperature: 150 degrees F.
5. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
6. 20/50 flame spread/smoke rating in accordance with ASTM E84
7. Thickness: 10 mil.
8. Connections: Brush on welding adhesive.
9. Factory-fabricated fitting covers
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

B. Stainless Steel Jackets

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

C. Aluminum Jacket

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Glass fiber insulated pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
3. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
4. Glass fiber insulated pipes conveying fluids above ambient temperature:
    a. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
    b. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
5. Inserts and Shields:
    a. Application: Piping 1-1/2 inches diameter or larger.
    b. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
    c. Insert location: Between support shield and piping and under the finish jacket.
    d. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
    e. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
6. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.
7. Exposed Insulated Pipe (from floor penetration to 10 feet above finished floor): Finish with Stainless Steel or aluminum jacket.

3.3 SCHEDULES

A. Plumbing Systems Insulation Schedule: (Provide insulation for piping and appurtenances of the following plumbing systems as scheduled below)
   1. Domestic Hot Water Supply and Recirculation, Tempered Supply:
      (a) Glass Fiber Insulation (All-Service Jacket):
         (1) Pipe Size Range:
            (a) up to and including 1 inch: 1-inch thick
            (b) 1-1/4 inch and over: 1-1/2 inch thick

      (b) Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in concrete walls)
         1) Pipe Size range:
            (a) Pipe Sizes up to and including 1 inch: 1-inch thick
            (b) Pipe Sizes over 1-1/4 inch: 1-1/2 inch thick.

   2. Domestic Cold, and Non-Potable Water Supply:
      (a) Glass Fiber Insulation (All-Service Jacket):
         (1) Pipe Size Range:
            (a) up to and including 2 inch: 1-inch thick
            (b) 1-1/4 inch and over: 1-1/2 inch thick

      (b) Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in concrete walls)
         1) Pipe Size range:
            (a) Pipe Sizes up to and including 1 inch: 1-inch thick
            (b) Pipe Sizes over 1-1/4 inch: 1-1/2 inch thick.

   2. Roof Drain and Emergency Roof Drain Bodies:
      a. Glass Fiber Insulation; Flexible Elastomeric Cellular Insulation
         1) 1-1/2-inch thick for Glass Fiberglass, 1 inch thick for Flexible Elastomeric Cellular Insulation
            (a) Where service is concealed Flexible Elastomeric insulation in factory color is adequate. In exposed, finished areas (i.e. gymnasium, auditorium, etc.) painted Glass Fiber with all service jacket is required (color selected by Architect).

   3. Rainwater and Emergency Rainwater Drainage Above Grade (all horizontal and all vertical piping):
      a. Glass Fiber Insulation (All-Service Jacket):
         1) Thickness:
            (a) all pipe sizes: 1-inch thick.

   4. Cold Condensate Drains:
      a. Flexible Elastomeric Insulation:
         1) Thickness:
            (a) all pipe sizes: 3/4-inch thick.

END OF SECTION 220719

SECTION 221005 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe, Pipe Fittings, Pipe Hangers and Supports, Valves, and Miscellaneous connections for piping systems.

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

1.2 RELATED REQUIREMENTS

A. Division 07 - Firestopping.

B. Division 09 - Painting and Coating.

C. Section 22 0100 - General Provisions

D. Section 22 0553 - Identification for Plumbing Piping and Equipment.

E. Section 22 0719 - Plumbing Piping Insulation.

F. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.

G. Section 22 1006 - Plumbing Piping Specialties

1.3 REFERENCE STANDARDS

A. Work and products provided in conformance to referenced standards listed below shall be in conformance with the latest editions of the referenced standards where the standards have a revision more current than the edition noted below.

B. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).

C. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).

F. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers; 1968.

G. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2004 (ANSI/ASME B31.9).

H. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2007.

I. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.

J. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2006.

K. ASTM B 32 - Standard Specification for Solder Metal; 2004.

L. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.

M. ASTM B 306 - Standard Specification for Copper Drainage Tube (DWV); 2002.

N. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2003a.

O. ASTM D 1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.

P. ASTM D 2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.

Q. ASTM D 2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings; 2007b.

R. ASTM D 2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems; 2004.

S. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2008.

T. ASTM D 2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2004.

U. ASTM D 2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.

V. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).

W. ASTM D 3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2006.

X. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002, and Errata 2002 (ANSI/AWWA C151/A21.51).

Y. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).

Z. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2005.

AA. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2004.

AB. IBC2018 - ICC - International Building Code; 2018

AC. IPC2018 - ICC - International Plumbing Code; 2018

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

AE. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers

Standardization Society of the Valve and Fittings Industry, Inc.; 2002.

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

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

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

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

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

1.4 SUBMITTALS

A. Piping & Pipe fitting Product Data: Provide manufacturer's data on pipe materials and pipe fittings specified herein. Submittals shall clearly indicate exact materials to be provided and applications where the submitted product is to be installed. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.

B. Hangers & Supports, Valve, & Misc. Product Data: Provide manufacturer's data for Hangers & supports, valve, & miscellaneous piping products specified herein. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.

C. Project Record Documents: Record actual locations of valves. Provide valve schedule as required in Section 22 0553 "Identification for Plumbing Piping and Equipment".

D. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data in Maintenance Manual.

E. Review of submittals which do not clearly indicate the information noted above may be delayed or rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review.

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

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

1.5 QUALITY ASSURANCE

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

1. Maintain one copy on project site.

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

C. Piping

1. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
2. Welder Qualifications: Certified in accordance with ASME (BPV IX) or ANSI B3l.l 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 B3l.l, paragraph 527.5 for shop and job site welding of piping work.
6. All grooved joint couplings, fittings, valves, and specialties shall be the products manufactured by Victaulic Co. or America. Grooving tools shall be of the same manufacturer as the grooved components.
7. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

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

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

1.6 REGULATORY REQUIREMENTS

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

B. Service piping to the building shall be tested in accordance with all requirements of the Local Authority Having Jurisdiction and Municipal Water Authority.

C. Conform to International Plumbing Code and all requirements of the local authority having jurisdiction, and Water Authority for installation of backflow prevention devices, service valving, and metering.

D. Provide certificate of compliance from local water authority having jurisdiction indicating approval of installation of backflow prevention devices, service valving, and meters.

E. When a meter pit is required, provide certificate of compliance from the local water authority having jurisdiction indicating approval of water meter pit construction plans prior to order/installation of water meter pit and all associated piping.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Provide factory applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from outside of pipe and tube.

E. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable waterproof wrapping.

F. Protect steel flanges and fittings from moisture and dirt by inside storage and enclosure or packaging with durable, waterproof wrapping.

1.8 FIELD CONDITIONS

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

1.9 EXTRA MATERIALS

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

B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 Except as otherwise indicated, provide factory fabricated products of the size, joint type, or class (thickness) indicated for each service. Where size, joint type, or class (thickness) is not indicated, provide products as determined by the installer for installation requirements and comply with the standards of the International Plumbing Code, International Fuel Gas Code, NFPA, Cast Iron Soil Pipe Institute (CISPI), and EPA as appropriate for each service.

A. All Sanitary, Waste, and Vent piping above grade or slab, including piping within crawl spaces, shall be Cast iron - no hub piping as specified. All Sanitary, Waste, and Vent buried below slab or grade shall be schedule 40 PVC or Cast Iron Hub and Spigot Piping as specified.

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

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

B. PVC Pipe: Schedule 40 ASTM D 2665 or ASTM D 3034. (No foam core permitted) - PVC Piping option for Sanitary Sewer and Waste piping systems shall not be permitted in areas with high temperature drainage discharge, these areas include but are not limited to: Kitchens, Boiler/Mechanical Rooms, etc. In areas with high temperature drainage discharge, Cast Iron Pipe shall be used in lieu of PVC piping. This cast iron pipe shall extend beyond the affected area to a minimum of 10ft. beyond the most downstream high temperature drain connection.

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

2.3 WASTE/SANITARY & VENT PIPING, ABOVE SLAB AND WITHIN CRAWL SPACES

A. Cast Iron Pipe: CISPI 301, hubless.

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

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

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

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

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

A. 18/8 Stainless Steel Pipe: ASTM A 74 service weight with FRM (fluorine rubber Vitron) sealing rings.

1. Manufacturers:
   a. Blucher
   b. Josam Stainless Steel
2. Fittings: 18/8 Stainless Steel.
3. Joints: Hub-and-spigot, compression type with "FPM" fluorine rubber sealing rings.

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

A. For Domestic Potable Water Piping, above slab, in pipe sizes 2-inch and smaller refer to Specification Section 221116.

B. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).

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

2.7 DOMESTIC POTABLE WATER PIPING, BELOW SLAB

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

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

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

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

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

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

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

2.9 RAINWATER & EMERGENCY RAINWATER PIPING, ABOVE GRADE

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

2. Fittings: Cast iron.

3. Joints: CISPI 310, ASTMC-564 neoprene gaskets and 300 series stainless steel clamp-and-shield assemblies with .0075in minimum thickness shield, and two clamps for sizes 1-1/2"-4", four clamps for sizes 5"-10", six clamps for sizes 12" and larger.

2.10 NATURAL GAS PIPING, ABOVE SLAB

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

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

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

2.11 CONDENSATE DRAIN PIPING, BELOW SLAB

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

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

2.12 FLANGES, UNIONS, AND COUPLINGS

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

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

B. Flanges (Pipe Size Over 1 Inch):

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

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

1. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier
2. Manufacturer: Subject to compliance with requirements, provide dielectric unions of one of the following:
   a. Atlas Products Co.
   b. Capital Mfg. Co., Div. of Harsco Corp.
   c. Eclipse, Inc.

d. Epco Sales, Inc.
e. FMC Corp.
f. McNally, Inc.
g. PSI Industries.
h. Stockham Valves and Fittings.

2.13 MISCELLANEOUS PIPING FABRICATION MATERIALS:

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

B. Pipe Nipples: Fabricate from same pipe as used for connected pipe; except do not use less than schedule 80 pipe where length remaining unthreaded is less than 1 1/2", and where pipe size is less than 1 1/4", and do not thread nipples full length (no close nipples.)

C. Copper Tube Unions: Provide standard products recommended by the manufacturer for use in the service indicated.

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

E. Welding Materials: Except as otherwise indicated, provide welding materials as determined by the installer to comply with installation requirements. Comply with Section 2-C, ASME Boiler Code for welding materials.

F. Soldering Materials: Except as otherwise indicated, provide lead free soldering materials as determined by the installer to comply with installation requirements.

G. Tin-Antimony Solder: ASTM B32, Grade 95YA.

H. Gaskets for Flanged Joints: ANSI B16.21 full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated.

I. Gaskets for Grooved Joints: Pressure responsive, ASTM D-2000. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.

2.14 PIPE HANGERS AND SUPPORTS

A. HORIZONTAL PIPING HANGERS AND SUPPORTS:

1. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information: size hangers and supports properly for piping including insulation, if any. Minimum hanger spacing shall be in accordance with IPC2009 Table 308.5.
   a. Adjustable Clevis Hangers: MSS Type 1, fabricated from steel.
   b. Adjustable Band Hangers: MSS Type 7, fabricated from steel.
   c. Adjustable Swivel Band Hangers: MSS Type 10.
   d. Clamp: MSS Type 4.

e. Double Bolt Clamp: MSS Type 3, including pipe spacers.
f. Adjustable Roller Hangers: MSS Type 43, including axle roller and clevis.
g. Steel Brackets: Welded structural steel shapes complying with one of the following:
   1) Light Duty: MSS Type 31.
   2) Medium Duty: MSS Type 32.
   3) Heavy Duty: MSS Type 33.

B. VERTICAL PIPING CLAMPS:

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

C. HANGER ROD ATTACHMENTS:

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

D. BUILDING ATTACHMENTS:

1. General: Except as otherwise indicated, provide factory fabricated building attachments of the MSS type and load rating indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or load rating is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published information. Size units properly for piping loading.
   a. Concrete Inserts: MSS Type l8, steel.
   b. Top Beam C-Clamps: MSS Type l9.
   c. C-Clamps: MSS Type 23, steel
   d. Top I-Beam Clamp: MSS Type 25.
   e. Side Beam Clamp: MSS Type 20.
   f. Beam Clamp/Eye Nut: MSS Type 28.
   g. Wide Flange Beam Clamp/Eye Nut: MSS Type 29.
   h. Beam Clamp/Extension Piece: MSS Type 30.

E. SADDLES AND SHIELDS:

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

indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size saddles and shields properly for insulation and vapor barriers (if any).

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

F. MISCELLANEOUS HANGER AND SUPPORT MATERIALS:

1. Metal Framing: Provide products complying with NEMA STD ML 1. Contractor shall provide all miscellaneous steel required for support of work within his contract.
2. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
3. Cement Grout: Portland cement (ASTM C l50, Type I or Type III,) and cleaned uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of l.0 part cement to 3.0 parts sand, by volume, with only the minimum amount of water required for placement and hydration.
4. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for the loads required, weld steel in accordance with AWS Standards.
5. Pipe Guides: Provide factory fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with two sections guiding spider bolted tightly to the pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of the length recommended by the manufacturer to allow indicated travel.

2.15 VALVES:

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

2.16 GATE VALVES:

A. Packing: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened, and equipped with gland follower. Guides for disc must be machined for accurate fit.

B. Comply with the following standards:

1. Cast Iron Valves: MSS SP-70
2. Bronze Valves: MSS SP-80
3. For Domestic Water Service Entrance piping:
   a. Flanged Ends 2-1/2” and Larger: Class 125, iron body bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge.
4. Manufacturer: Subject to compliance with requirements, provide gate valves of one of the following:
   a. Crane Co., Valve Div.
   b. Milwaukee Valve Co., Inc.
   c. NIBCO, Inc.

C. DRAIN VALVES:

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

D. BALL VALVES:

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

E. BUTTERFLY VALVES:

1. General: Comply with MSS SP-67. Where butterfly valves are used as shutoffs for terminal or equipment removal or repair, select lug type valves. Select wafer type valves for other applications. Grooved end butterfly valves shall be used in grooved joint piping systems. Provide gear operation on butterfly valves 8" and larger. Provide valve bodies with 2" necks where insulation is 2" thick or greater.

F. SWING CHECK VALVES:

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

G. GLOBE VALVES:

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

H. VALVE FEATURES:

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

2.17 LOW PRESSURE Y-TYPE PIPELINE STRAINERS:

A. General: Comply with FCI 73-1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64" perforations @ 233 per sq. in.

1. Threaded Ends: 2" and Smaller: Brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with pipe plug.
2. Threaded Ends: Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with pipe plug.
3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted pipe plug.
4. Manufacturer: Subject to compliance with requirements, provide low pressure Y-Type strainers of one of the following:
   a. Armstrong Machine Works.
   b. Hoffman Specialty, ITT Fluid Handling Div.
   c. Metraflex Co.
   d. Crane Co., Valve Div.
   e. Milwaukee Valve Co., Inc.
   f. NIBCO, Inc-

2.18 FLOW CONTROLS

A. Manufacturers:

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

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. PIPING INSTALLATION:

1. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connection, within 1/16" misalignment tolerance.
2. Install all piping in accordance with International Plumbing Code (IPC), International Fuel Gas Code (IFGC), and ANSI B31 Code for Pressure Piping requirements as applicable.
3. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanently enclosed elements of the building; limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
4. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical equipment spaces and enclosures.
5. Piping System Joints: Provide joints of the type indicated in each piping system.
6. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Read threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound/tape on male threads at each joint and tighten joint to leave not

more than 3 threads exposed.

7. Install Press Fittings in accordance with manufacturer's installation instructions.
9. Flanged Joints: Match flanged within piping systems, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
10. Insulating Unions: Comply with manufacturer's instructions for installing unions. Install unions in a manner which will prevent galvanic action and stop corrosion when joining ferrous and non-ferrous piping.
11. Grooved Joints: Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to grooved. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the job site and review and installation. Contractor shall remove and replace any joints deemed improperly installed.
12. Unless noted otherwise on the Plumbing drawings all Sanitary/Waste, Kitchen Sanitary/Kitchen Waste, Rainwater, Emergency Rainwater, and Storm piping shall be installed at a minimum continuous 2% slope (1/4" per foot).
13. Unless noted otherwise on the Plumbing drawings all Vent and Condensate Drainage piping shall be installed at a minimum continuous 1% slope (1/8" per foot).
14. Slope all exterior gas piping at a minimum continuous slope of 1/4" per 15 feet and provide condensate drip traps at all low points at accessible location within the conditioned building.

B. PIPING INSPECTION:

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

C. PIPING TESTS:

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

b. Once a passing test is performed this information must be documented and supervised by the Architect/Owner/Engineer and this document must be forwarded to PECO for their records/review.

D. HANGERS AND SUPPORTS:

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

E. BUILDING ATTACHMENTS INSTALLATION:

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

F. HANGERS AND SUPPORTS INSTALLATION:

1. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire of perforated metal to support piping, and do not support piping from other piping.
2. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
3. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.
   a. Do not fasten or anchor work to concrete floor deck except where individually approved by Structural Engineer and Architect.
   b. Do not fasten or anchor any work directly to metal roof deck.
   c. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
   d. Provisions for movement:
      1) Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.

2) Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3) Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B3l are not exceeded.
4) Insulated Piping: Comply with the following installation requirements:
5) Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
6) Shields: Where low compressive strength insulation of vapor barriers are indicated on cold water piping, install coated protective shields.
7) Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

G. PIPE GUIDE INSTALLATION:

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

H. PIPING ANCHORS INSTALLATION:

1. Install anchors at the proper location to prevent stresses from exceeding those permitted by ANSI B3l, 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 B3l and with AWS standards.
   b. Anchor Spacings: Where not otherwise indicated, install anchors at the ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

I. ADJUSTMENT OF HANGERS AND SUPPORTS:

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

J. VALVE INSTALLATION:

1. General: Except as otherwise indicated, comply with the following requirements:
   a. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   b. Install valves with stems pointed up, in the vertical position, where possible, but in no case with stems pointed downward from a horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
   c. Insulation: Where insulation is indicated, install extended stem valves, arranged in the proper manner co receive insulation.
   d. Applications Subject to Shock; Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.
   e. Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless the bronze and steel are separated

by a dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.

f. OS&Y Valve Stem: Select and install gate valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
g. Non-Metallic Disc: Limit the selection and installation of valves with non-metallic discs to locations indicated and where foreign material in the piping system can be expected to prevent tight shut off of metal seated valves.
h. Renewable Seats: Select and install valves with renewable seats, except where frequent usage of the valves is indicated.

K. STRAINER INSTALLATION

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

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Provide flow controls in water recirculating systems where indicated.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

I. Domestic Water System shall be sanitized and flushed at the end of each phase.

3.6 SERVICE CONNECTIONS

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

3.7 SCHEDULES

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

END OF SECTION 221005

SECTION 221006 - PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roof drains.

B. Floor Drains.

C. Floor Sinks.

D. Cleanouts.

E. Hose bibbs.

F. Non-Freeze Wall Hydrants.

G. Backflow preventers.

H. Interceptors.

I. Plaster Traps.

J. Thermostatic mixing valves.

K. Washdown Connection Boxes.

L. Water hammer arrestors.

1.2 RELATED REQUIREMENTS

A. Division 01 - Summary: Product requirements for Owner furnished kitchen equipment.

B. Section 22 0100 - General Provisions

C. Section 22 1005 - Plumbing Piping.

D. Section 22 4000 - Plumbing Fixtures.

E. Section 22 3000 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers; 2001 (R2007).

B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; The American Society of Mechanical Engineers; 2003.

C. ASSE 1011 - Hose Connection Vacuum Breakers; American Society of Sanitary Engineering; 2004 (ANSI/ASSE 1011).

D. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent; American Society of Sanitary Engineering; 2002 (ANSI/ASSE 1012).

E. ASSE 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type; American Society of Sanitary Engineering; 2004, and Errata 2005 (ANSI/ASSE 1019).

F. IBC2009 - ICC - International Building Code; 2018

G. IPC2009 - ICC - International Plumbing Code; 2018

H. IFGC2009 - ICC - International Fuel Gas Code; 2018

I. PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute; 2009.

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturer's data for all Piping Specialty specified herein and on the Plumbing Drawings. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.

C. Maintenance Data: Submit maintenance data and spare parts lists for each Piping Specialty. Include this data in Maintenance Manual.

D. Review of submittals which do not clearly indicate the information noted above may be delayed or rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review.

E. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

F. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.

G. Operation Data: Indicate frequency of treatment required for interceptors.

H. Maintenance Data: Include installation instructions, routine maintenance instructions, spare parts lists, exploded assembly views.

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

1. See Division 01 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 EXTRA MATERIALS

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

B. Supply for Owner's use in maintenance of project:

1. Two repair kits including loose key for non-freeze wall hydrants.
2. Two hose end vacuum breakers for hose bibbs.
3. One Lavatory thermostatic mixing valve for every 5 installed units
4. One Water Hammer Arrestor for every 5 installed units of ea. type

PART 2 - PRODUCTS

2.1 DRAINS

A. Acceptable Manufacturers (for all drainage products):

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

B. Roof Drains (RD-1): Large Area Roof Drains **(ROOF DRAINS WILL BE FURNISHED BY THE PLUMBING CONTRACTOR AND INSTALLED BY THE ROOFING CONTRACTOR)**

1. Refer to Plumbing Drawings for locations and connection sizes
2. Assembly: ASME A112.6.4.
3. Size: 16" diameter
4. Body: Lacquered cast iron with sump.
5. Strainer: Removable cast iron dome with vandal proof screws.
6. Accessories: Coordinate with roofing type.
    a. Membrane flange and membrane clamp with integral gravel stop.
    b. Adjustable under deck clamp.
    c. Roof sump receiver.
    d. Waterproofing flange.
    e. Expansion joint (Install only where directed by engineer in field)
    f. Adjustable non-puncturing extension sleeve for roof insulation.
7. Basis of Design:
    a. J.R.Smith: Model 1010-Extension-R-C-CID-1710XJ.

C. (RD-2) Roof Drains - General Canopy Drains: **(ROOF DRAINS WILL BE FURNISHED BY THE PLUMBING CONTRACTOR AND INSTALLED BY THE ROOFING CONTRACTOR)**
1. Refer to Architectural Drawings for locations and Plumbing drawings for connection sizes
2. Assembly: ASME A112.6.4.

3. Body: Lacquered cast iron with sump, outlet size as noted on plumbing drawings, connection style as required for connection to rainwater piping (Note: provide with threaded outlet in locations requiring quick turn outlet elbow)
4. Strainer: Removable 8-1/2 in. low profile cast iron dome with vandal proof screws.
5. Accessories: Coordinate with roofing type.
   a. Membrane flange and membrane clamp with integral gravel stop.
   b. Adjustable under deck clamp.
   c. Roof sump receiver.
   d. Waterproofing flange.
   e. Fixed Height non-puncturing extension sleeve for built up roof insulation. (verify required extension height in field)
   f. Quick turn elbow (where required for tight structural clearances, canopy areas etc.) JR Smith fig.# 2648S
6. Basis of Design:
   a. J.R.Smith: Model 1330-Extension-R-C-CID-1710.

D. Condensate Drain (CD-1):

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

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

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

F. Floor Drain (FD-2) Boiler Room:

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

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

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

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

1. 12 in. square, 14 ga. 304SS receiver, cast 316SS ribbed non-tilt loose set grate with 1/2 inch square holes, seepage control holes, perforated SS dome bottom strainer
   a. Provide Pro-Set "trap-guard" sewer gas prevention system in all floor drains.
2. Refer to Floor plans for connection sizes.
3. Depth: 10 inches.
4. Grate Style: Half Grate (Install drain without grate and furnish grate separately to owner). Open portion of grate shall be toward the wall side (rear) of the floor sink.
5. Install as indirect waste receptor with rim above finished floor. Verify all requirements with AHJ prior to installation.
6. Basis of Design:
   a. J.R. Smith: Model 9694-12.

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

1. 12 in. square, 14 ga. 304SS receiver, cast 316SS ribbed non-tilt loose set grate with 1/2 inch square holes, seepage control holes, perforated SS dome bottom strainer
   a. Deep Seal P-trap
   b. Pro-Set "trap-guard" sewer gas prevention system
2. Refer to Floor plans for connection sizes
3. Depth: 4 inch
4. Flashing Clamp (Verify clamp to rim dimension with floor construction prior to order)
5. Grate Style: Half Grate
6. Basis of Design:
   a. J.R. Smith: Model 9691-12.

2.2 CLEANOUTS

A. Manufacturers:

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

B. Cleanouts at Exterior Areas (CTG):

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

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

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

D. Cleanouts at Interior Finished Wall Areas:

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

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

2.3 HOSE BIBBS (HB)

A. Manufacturers:

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

B. Interior Hose Bibbs (HB-1):

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

2.4 NON-FREEZE WALL HYDRANT (NFWH)

A. Manufacturers:

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

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

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

2.5 WASHDOWN CONNECTION BOX (WB) – NEW GANG TOILET ROOMS

A. Box Manufacturers:

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

B. Washdown Connection Box (WB-1)

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

2.6 BACKFLOW PREVENTERS

A. Manufacturers:

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

B. Reduced Pressure Zone Backflow Preventers (3/4"-2"):
1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under

back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two quarter turn ball valves, strainer, air gap fitting, four test cocks and in-line strainer.
a. Watts Model 909-QT-S (3/4"-1") w/series 909AG air gap fitting
b. Watts Model 909-M1-QT-S (1¼"-2") w/series 909AG air gap fitting

2.7 PLASTER TRAPS (PT)

A. Construction:

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

2.8 THERMOSTATIC MIXING VALVES

B. Thermostatic Mixing Valves:

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

B. Lavatory Mixing Valves:

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

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

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

D. Emergency Eyewash/Facewash Mixing Valves:

1. Advanced thermal actuators, internal cold water bypass (ensures cold water flow in the event of loss of hot water), meets ASSE 1071, vandal-resistant locking mechanism to secure temperature setting, factory tested, union triple-duty checkstops,

rough bronze, temperature/pressure gauge on outlet.

a. Powers HydroGuard XP Series Emergency Tempering Valve with Cold Water Bypass: Model ES-150-11

2.10 WATER HAMMER ARRESTORS

A. Manufacturers:

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

B. Water Hammer Arrestors:

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all piping specialties in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil or Teflon tape. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade at all locations where sanitary or storm piping exits the building footprint.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved portable water protection devices on plumbing lines as indicated on drawings and where contamination of domestic water may occur; including boiler makeup water lines, chemical mixers within janitor rooms, fire sprinkler systems, irrigation systems, flush valves, interior and exterior hose bibbs. Additional backflow prevention is not required when the connected equipment is provided with integral backflow prevention in accordance with the International Plumbing Code and the equipment is permanently/directly connected to the water supply.

F. Pipe relief from backflow preventers with air gap drain fitting to nearest adequately sized floor drain or building exterior.

G. Provide pressure gauges on inlet and outlet of all pressure reducing valves, backflow preventer assemblies.

H. Install water hammer arrestors complete with accessible isolation valve on water supply piping to urinal/water closet flush valves and automatic washer connections.

I. Install floor drains at all incoming domestic water service and fire protection service entrance piping/valving. Coordinate location of floor drain prior to rough in.

END OF DOCUMENT 221006

SECTION 221116 - DOMESTIC WATER PIPING (PEX-A)

PART 1 - GENERAL

1.1 SUMMARY

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

B.

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

1.2 RELATED REQUIREMENTS

A. Division 07 - Firestopping

B. Division 09 - Access Doors and Panels

C. Division 09 - Painting

D. Division 31 - Excavation, Fill and Trenching

E. Section 220502 - Excavation, Backfill and Compaction of Utilities

F. Section 220553 - Identification for Plumbing Piping and Equipment.

G. Section 220719 - Plumbing Piping Insulation.

H. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.

I. Section 220800 - Plumbing System Commissioning

J. Section 221006 - Plumbing Piping Specialties

1.3 REFERENCE STANDARDS

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

B. ASTM International

1. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials
3. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops
4. ASTM F876 Standard Specification for Cross-linked Polyethylene (PEX) Tubing

5. ASTM F877 Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
6. ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing

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

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

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

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

E. International Code Council (ICC)

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

F. International Association of Plumbing Officials (IAPMO)

1. Uniform Plumbing Code (UPC)

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

1. National Standard Plumbing Code (NSPC)

H. Plastics Pipe Institute (PPI)

1. PPI Technical Report TR-4/06

I. Uponor, Inc.

1. Uponor Professional Plumbing Installation Guide, Latest Update

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Standard grade hydrostatic pressure ratings from Plastics Pipe Institute (PPI) in accordance with TR-3 as listed in TR-4. The following three standard-grade hydrostatic ratings are required.
   a. 200°F (93°C) at 80 psi (551 kPa)
   b. 180°F (82°C) at 100 psi (689 kPa)
   c. 73.4°F (23°C) at 160 psi (1,102 kPa)
2. All PEX tubing (1/2” thru 2”) shall be installed with Uponor PEX-a Pipe Support with a maximum distance of 10” between pipe support pieces. PEX-a Pipe Support shall terminate a maximum of 5” away from the centerline of the adjacent fitting. All PEX-a tubing provided on the project shall be insulated as follows:

a. GLASS FIBER
   1. Manufacturers:
      a. Knauf Fiber Glass: www.knaufusa.com.
      b. Johns Manville Corporation: www.jm.com
      c. Owens Corning Corp: www.owenscorning.com
      d. Certain Teed Corporation: www.certainteed.com.
      e. Substitutions: Refer to Division 01
   2. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible, all service jacket.
      a. 'K' value" ASTM C 177, 0.24 at 75 degrees F.
      b. Maximum service temperature: 850 degrees F.
      c. Maximum moisture absorption: 0.2 percent by volume.
   3. Insulation: ASTM C547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
      a. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
      b. Maximum service temperature: 650 degrees F.
      c. Maximum moisture absorption: 0.2 percent by volume.
   4. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.
   5. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
   6. Vapor Barrier Lap Adhesive:
      a. Compatible with insulation.
   7. Insulating Cement/Mastic:
      a. ASTM C 195; hydraulic setting on mineral wool.

b. INSULATION SCHEDULES
   1. Domestic Cold Water:
      a. Glass Fiber Insulation (All-Service Jacket):
         1) Pipe Size Range:
            (a) up to and including 2-inch: 1-inch thick
   2. Domestic Hot Water Recirculation:
      a. Glass Fiber Insulation (All-Service Jacket):
         1) Pipe Size Range:
            (a) up to and including 1-inch: 1-inch thick
            (b) 1-1/4-inch and larger: 1-1/2-inch thick
   3. Domestic Hot Water Supply:
      a. Glass Fiber Insulation (All-Service Jacket):
         1) Pipe Size Range:
            (a) up to and including 1-inch: 1-inch thick
            (b) 1-1/4-inch and larger: 1-1/2-inch thick
   4. Tempered Domestic Water Supply:
      a. Glass Fiber Insulation (All-Service Jacket):
         1) Pipe Size Range:
            (a) all sizes: 1-inch thick"

B. Performance Requirements: To provide a PEX tubing hot and cold potable water distribution system, which is manufactured, fabricated and installed to comply with regulatory agencies and to maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.

1. Comply with ANSI/NSF Standard 14.
2. Comply with ANSI/NSF Standard 61.
3. Show compliance with ASTM F877.
4. Show compliance with ASTM E119 and ANSI/UL 263 through certification listings with Underwriters Laboratories, Inc. (UL).
    a. UL Design No. L557 — 1 hour wood frame floor/ceiling assemblies
    b. UL Design No. K913 — 2 hour concrete floor/ceiling assemblies
    c. UL Design No. U372 — 1 hour wood stud/gypsum wallboard wall assemblies
    d. UL Design No. V444 — 1 hour steel stud/gypsum wallboard wall assemblies

1.4 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Product Data: Submit manufacturer's product submittal data and installation instructions.

C. Samples: Submit selection and verification samples of tubing.

D. Quality Assurance/Control Submittals: Submit the following:

1. Test Reports: Upon request, submit test reports from recognized testing laboratories.
2. Certificates: Submit the following:
    a. Manufacturer's certificate that products comply with specified requirements.
    b. Certificate indicating that the installer is authorized to install the manufacturer's products

E. Closeout Submittals: Submit the following:

1. Warranty documents specified herein
2. Operation and maintenance data

1.5 QUALITY ASSURANCE

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

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

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

C. Certifications: Provide letters of certification as follows:

1. Installer is trained by the PEX tubing manufacturer to install the PEX potable water distribution system.

2. Installer will use skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed trades professional.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1. Store PEX tubing in cartons or under cover to avoid dirt or foreign material from being introduced into the tubing.
2. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of tubing exposed to direct sunlight.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 HOT AND COLD DOMESTIC WATER DISTRIBUTION SYSTEM

A. Manufacturer: Uponor

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

2.2 MATERIALS

A. Tubing

1. Material: Crosslinked polyethylene (PEX) manufactured by PEX-a or Engel method
2. Type: Wirsbo AQUAPEX
3. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency
4. Standard grade hydrostatic design and pressure ratings from PPI
5. Fire-rated assembly listings in accordance with ANSI/UL 263
   a. UL Design No. L557 — 1-hour wood frame floor/ceiling assemblies
   b. UL Design No. K913 — 2-hour concrete floor/ceiling assemblies
   c. UL Design No. U372 — 1-hour wood stud/gypsum wallboard wall assemblies
   d. UL Design No. V444 — 1-hour steel stud/gypsum wallboard wall assemblies

6. Minimum Bend Radius (cold bending): No less than six times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.
   a. Uponor Metal Bend Support #A5110xxx
   b. Uponor Plastic Bend Support #A5xxxxxx
7. Nominal Inside Diameter: Provide tubing with nominal inside diameter, in accordance with ASTM F876 as indicated.
   a. ⅜ inch [9.53mm]
   b. ½ inch [12.7mm]
   c. ¾ inch [19.05mm]
   d. 1 inch [25.4mm]
   e. 1¼ inch [31.75mm]
   f. 1½ inch [38.1mm]
   g. 2 inch [50.8mm]

B. Fittings

1. Material: Fitting assembly is manufactured from material listed in paragraph 5.1 of ASTM F1960.
2. Material Standard: Comply with ASTM F1960.
3. Expansion Fitting: PEX-a cold expansion fitting.
   a. Assembly consists of the appropriate ProPEX insert with a corresponding ProPEX Ring.
   b. Install on all domestic hot, return and cold water piping every 50 feet (max.) of straight-length horizontal piping.
   c. Refer to manufacturer's Expansion Joint Installation and Data Sheets for necessary spacing, support, anchors, guides, etc.

C. Manifolds

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

D. Accessories

1. Angle stops and straight stops that are compatible with PEX tubing are supplied by the PEX tubing manufacturer.
2. Bend supports designed for maintaining tight radius bends are supplied by the PEX tubing manufacturer.
3. ProPEX expander tool to install the ASTM F1960 compatible fittings are supplied by the PEX tubing manufacturer.
4. The tubing manufacturer provides clips and/or PEX rails for supporting tubing runs.
5. All horizontal tubing hangers and riser clamps are epoxy-coated material.

6. Provide pipe hangers and supports in accordance with specifications, PEX-A pipe manufacturers recommendations, IPC, All local codes, Authorities having Jurisdiction, etc.
7. Straight-Through support: Uponor # F5140500
8. Plastic Drop Ear Bend Support: Uponor #F5200xxx
9. PEX Wall Support Bracket: Uponor #A5750500
10. Metal Drop Ear Bend Support: Uponor #F5120xxx
11. PEX-A Pipe Support: Uponor #F704xxxx
12. PEX-A Pipe Support: Uponor #F704xxxx
    a. Non-combustible, self-gripping, galvanized steel channel. Provides continuous, uninterrupted support of PEX-A pipe, allowing hanger placement similar to that of metallic pipe. Pipe Supports **MUST** be used on all PEX-A pipe installations.
    b. Install on all vertical and horizontal piping.
    c. Refer to the Uponor PEX-A Pipe Support Instruction Sheet for installation guidelines.

PART 3 – EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 EXAMINATION

A. Site Verification of Conditions:

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

3.3 INSTALLATION

A. Uponor AQUAPEX Tubing

1. Install Wirsbo AQUAPEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.
2. Do not install PEX tubing within 6 inches [152 mm] of gas appliance vents or within 12 inches [305 mm] of any recessed light fixtures.
3. Do not solder within 18 inches [457 mm] of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
4. Do not expose PEX tubing to direct sunlight for more than 30 days.
5. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
6. Use grommets or sleeves at the penetration for PEX tubing passing through metal studs.
7. Protect PEX tubing with sleeves where abrasion may occur.
8. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.
9. Use tubing manufacturer-supplied bend supports where bends are less than six times the outside tubing diameter.

10. Minimum horizontal supports are installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.
11. PEX riser installations require epoxy-coated riser clamps installed at the base of the ceiling per floor.
12. A mid-story support is required for riser applications.
13. Pressurize Wirsbo AQUAPEX tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi (173 kPa) above normal working pressure of the system.
14. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32°F (0°C).

B. Through-penetration Firestop

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

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

3.4 FIELD QUALITY CONTROL

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

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

3.5 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. Repair or replace damaged installed products.

C. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

D. Remove construction debris from project site and legally dispose of debris.

3.6 SLEEVES

A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.

B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal.

C. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.

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

3.7 VALVES:

A. All valves shall be lead free

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

C. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as determined by installer for installation requirements. Comply with ANSI B31.1

D. BALL VALVES:

1. Provide Lead Free Ball Valves

2. Select with full port area, blow-out proof stem, dezincification resistant 2-piece brass/bronze body, hard chrome plated forged brass/bronze ball rated not less than 600# WOG.

3. Valves for use in insulated piping systems shall be equipped with 2" extended handles of non-thermal conductive material. A protective sleeve shall allow operation of the valve without disturbing the installation and providing a vapor seal. Product shall be NIBCO NIB-SEAL or approved equal.

4. Comply with the following standards: MSS SP-110

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

6. Domestic Water Service:
   a. Threaded Ends 4” and Smaller: 600# W.O.G., forged bronze 2 piece body, hard chrome plated forged bronze/brass ball, blow-out proof stem.
      1) Basis of Design: NIBCO T685
   b. Press-Fit 3” and Smaller: 600# W.O.G., forged bronze 2 piece body, hard chrome plated forged bronze/brass ball, blow-out proof stem.
      1) Basis of Design: NIBCO

c. PEX Ends 2-inch and smaller: 250 CWP, lead-free brass body and ball, blow-out proof stem
   1) Basis of Design: Uponor LF Commercial Ball Valve LFC482XXXX

E. CHECK VALVES:

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

F. CIRCUIT SETTER VALVES:

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

G. DRAIN VALVES:

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

3. Threaded Ends:
   a. 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection,
4. Manufacturer: Subject to compliance with requirements, provide drain valves of one of the following:
   a. NIBCO, Inc. www.nibco.com
   b. Watts, Inc. www.watts.com
   c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.

H. SWING CHECK VALVES:

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

3.8 INSTALLATION

A. ALIGNMENT:

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

B. BUILDING ATTACHMENTS INSTALLATION:

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

inserts. Prior to placing concrete, install nut in insert and screw threaded rod thru nut until rod is firmly against top of the insert body.

C. ESCUTCHEONS:

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

D. PIPING ANCHORS INSTALLATION:

1. Install anchors at the proper location to prevent stresses from exceeding those permitted by ANSI B3l, 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 B3l and with AWS standards.
   b. Anchor Spacing's: Where not otherwise indicated, install anchors at the ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

E. PIPE GUIDE INSTALLATION:

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

F. PIPING HANGERS & SUPPORTS:

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

4. Prime coat exposed steel hangers and supports. Refer to Division 09 - Painting Hanger and supports located in crawl spaces, pipe shafts and suspended ceiling spaces are not considered exposed.
5. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22054
6. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
7. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.
   a. Do not fasten or anchor work to concrete floor deck except where individually approved by Structural Engineer and Architect.
   b. Do not fasten or anchor any work directly to metal roof deck.
   c. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
   d. Provisions for movement:

      1) Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
      2) Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
      4) Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
      5) Shields: Where low compressive strength insulation of vapor barriers are indicated on cold water piping, install coated protective shields.
      6) Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

G. ADJUSTMENT OF HANGERS AND SUPPORTS:

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

H. PIPING INSPECTION:

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

I. PIPING INSTALLATION:

1. Install all piping in accordance with International Plumbing Code (IPC), and ANSI B31 Code for Pressure Piping requirements as applicable.

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

J. PIPING TESTS:

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

K. PIPE GUIDE INSTALLATION:

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

L. VALVE INSTALLATION:

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

3.9 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install ball valves for shut-off and to isolate equipment, part of system or vertical risers.

C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Provide flow controls in water recirculating systems where indicated.

3.10 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean. Sanitize and flush domestic water system after each phase.

B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.11 PROTECTION

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

END OF SECTION 221116

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This work shall consist of the construction of sanitary sewer gravity, sanitary sewer connections, miscellaneous fittings, and testing at designated locations, to the prescribed lines, grades, and dimensions.

B. Section Includes:

1. PVC pipe and fittings.
2. Nonpressure-type transition couplings.
3. Expansion joints and deflection fittings.
4. Cleanouts.
5. Encasement for piping.
6. Concrete.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 QUALITY ASSURANCE

A. Comply with applicable portions of National Standard Plumbing Code, West Whiteland Township Plumbing Code and other applicable Township Codes pertaining to selection and installation of sanitary sewage system materials and products.

B. Conform to applicable requirements of the West Whiteland Township specification for sanitary sewers.

1.5 REQUIREMENTS, TESTS AND INSPECTION

A. All materials shall be tested for conformance to the current specifications, and in accordance with the current standard test methods, of technical societies, institutes, associations of Federal and State specifications, as called for in these specifications, in the Special Specifications of the Contract or as called for by the Design Professional. Current specifications and current standard test methods are defined as the latest editions, amendments of revisions that are current at the time of receipt of bids.

B. West Whiteland Township will inspect the tap connection of new sewer to the West Whiteland Township Sewers. Contractor to pay the cost of the West Whiteland Township inspection.

C. Manufacturer's Qualifications: All materials shall be obtained from firms regularly engaged in manufacture of sewer system products of types, materials, and sizes required, whose products have been in satisfactory use of similar service for not less than 5 years.

D. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with sanitary sewage work similar to that required for project.

E. Codes and Standards - Plumbing Code Compliance: Comply with applicable portions of West Whiteland Township Plumbing and Utility Code pertaining to selection and installation of sewage system's materials and products.

1.6 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings.
2. Non-pressure couplings
3. Expansion joints and deflection fittings.
4. Cleanouts.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. At project closeout, submit record drawings of installed sewage piping and products, in accordance with requirements of Division 01.

C. Product Certificates: For each type of pipe and fitting.

D. Field quality-control reports.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.9 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by WCASD or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the Architect and the WCASD representative no fewer than three days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without the WCASD's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. General: Each pipe and fitting: Mark with manufacturer's name or trademark, specification designation, pipe class and strength, production shift code, and manufacture date and location.

B. Pipe and Fittings: ASTM D3034, wall thickness classification SDR26, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM D3212, elastomeric seals for gasketed joints conforming to ASTM F-477. Pipe shall be factory tested and conform to ASTM D-2444 (impact resistance) and conform to ASTM D-2444 (impact resistance) and ASTM D-2152 (extrusion quality).

2.2 NONPRESSURE-TYPE COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Coupling/Adapters: For gravity sewer connections between different types of pipe and point repairs, approved manufacturers are as follows:
   a. FERNCO Joint Sealer Co. with shear ring.
   b. DFW by NDS non-shear.

B. Flexible Gasket Connectors (ASTM C923) for connecting pipes to sewer manholes:

1. Approved manufacturers for connectors connecting with diameter dimension of polyvinyl chloride (PVC) ASTM D3034, and PVC ASTM F679 to sewer manholes:
   a. A-LOK Products Inc., A-LOK or A-LOK X-CEL.
   b. Press Seal Gasket Corporation, Press Boot, PSX Series, Econoseal, or equal.
   c. NPC Incorporated, KOR-N-SEAL I Toggle Korband with Series 106 or 406 rubber boot.

2.3 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, dura-coated cast iron body with integral anchor flange, secured scoriated cover with lifting device.
2. Approved Manufacturers:
   a. Zurn or equal
3. Top-Loading Classification(s): Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM D3034, SDR 26 PVC pipe and fittings.

2.4 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4,000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420-MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4,000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
   a. Invert Slope: 1 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
   a. Slope: 4 percent.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping

layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Excavation shall not be started until the exact locations of utility structures have been determined in the field by the Contractor. Flow in existing sewage facilities shall be maintained during construction of the new sewers. The Contractor is responsible for bypass pumping and/or piping as is necessary to maintain flows

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

D. Where trench openings for pipes remain open overnight within or adjacent to roadways or sidewalk open to traffic and pedestrians, they shall be adequately maintained and protected to the satisfaction of the Design Professional. Provide, install and operate a dewatering system when necessary to stabilize the trench. The dewatering system shall be removed upon completion of the backfill. Trenches shall not be open more than three hundred (300) feet in advance of the laid pipe within approval.

E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

F. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

G. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at slope as indicated on the drawings.
2. Install piping with 36-inch minimum cover.
3. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

I. Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

J. The manufacturer’s recommendations for pipe assembly must be closely followed. Care must be taken to clean the mating surfaces of the joints before jointing. The jointing surfaces shall be lubricated as recommended by the manufacturer. The pipe ends shall be aligned and assembled by hand, bar or the use of a come-along. In all instances the ends of the pipe must be protected against damage.

K. Protection of Pipes: The mouth of the pipes, in the trenches, shall be carefully protected from rock falls or damage from any other source. In addition, the mouth of the pipes shall be provided with means to prevent earth or any other substance from entering.

L. Length of Pipes: All pipes used in the construction of sewers, and other connects shall be the maximum length produced, except where shorter lengths are required for closures, curved sewers or to secure proper locations for laterals.

M. Make changes in direction for waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

N. Provisions of Lateral Connections:

1. Laterals shall be constructed to have a direct fall between the building and the connection at the sewer.

O. All pipe shall be placed on a stone or concrete cradle as shown on the plans. Pipe with less than 3 feet of cover shall be encased in concrete, minimum thickness 9 inches.

P. Connections: Laterals shall be connected to the sewer pipe with factory manufactured wye branches.

Q. Installing Pipe Fittings:

1. After the pipes are placed in the trench, they shall be prepared for coupling by thoroughly cleaning and then lubricating the joint. For pipes manufactured to accept "O" ring gaskets, the groove and the "O" ring gasket shall be lubricated as recommended by the manufacturer. The gasket shall be placed in the groove and the tension shall be equalized by inserting a suitable tool under the gasket and running it around the pipe 3 times.
2. For pipes manufactured to accept fin type gaskets, the inside surface of the bell or groove and the gasket shall be lubricated as recommended by the manufacturer.
3. After the joint is lubricated, the pipes shall be coupled immediately. The pipes shall be pulled up tightly by using a winch, come-along or other appropriate method. A visual check shall be made to see that the pipe is properly connected.

R. Trenches shall be backfilled with material except where select backfill is deemed necessary by the Design Professional. Backfill and compaction shall occur in lifts not exceeding six inches in depth. The layers shall be individually compacted at is optimum moisture content as determined by ASTM D 1557 to a minimum of 95% of maximum density according to AASHTO T 180.

S. Where sewers are constructed in two or more stages, a temporary pipe plug shall be constructed in the end of the pipe at the termination of each stage.

T. When work is not in progress, and at the end of each work day, securely plug open ends of pipe and fittings to prevent trench water, earth, or other substances form entering the pipes or fittings.

U. The Contractor shall flush each section of pipe as necessary to remove all foreign material which may have entered during construction.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
2. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
   a. Unshielded flexible couplings for pipes of same or slightly different OD.
   b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches, and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 15 by 15 by 4 inches deep. Set with tops not more than 1” above surrounding grade.

C. Set cleanout frames and covers in pavement and roads with tops flush with pavement surface.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Make connections to existing piping:

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches (of concrete with 28-day compressive strength of 4,000 psi.
2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required, remove manhole and close open ends of remaining piping. Fill with stone, rubble, gravel, or compacted dirt.

C. Backfill to grade according to Section 312000 "Earth Moving."

3.8 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
   a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
   b. Close openings in system and fill with water.
   c. Purge air and refill with water.
   d. Disconnect water supply.
   e. Test and inspect joints for leaks.
6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Test plastic gravity sewer piping according to ASTM F1417.
7. Low Pressure Air Test:
   a. Test each newly installed section of gravity sewer line between manholes. No test may be conducted on a pipe which does not have a wetted inside condition. Normally require flushing will suffice to accomplish this requirement if testing is made immediately after the flushing procedure. The test shall be performed in accordance with ASTM C-828.
   b. Slowly introduce air pressure to approximately 5.0 psig. The compressor must be equipped to control the air entry rate and shall have a positive method of preventing pressure from exceeding 5 psig.
      1) If ground water is present, determine its elevation above the springline of the pipe by means of piezometric tube. For every foot of ground water above the springline of the pipe, increase the starting air pressure reading by 0.43 psig. Do not increase pressure above 10 psig.
   c. Allow pressure to stabilize for at least four (4) minutes. During the stabilization period, all plugs and fittings shall be checked with a water-soap solution. If any leakage is found, the pressure in the line shall be released and the leaking plugs tightened. Adjust pressure to 3.0 psig or the increased test pressure as determined above if ground water is present. Start the test.
   d. Test:
      1) Determine with the test duration for a sewer section with a single pipe size from the table below.

Low Pressure Air - Test Times (min:sec)				
Nominal Pipe Size	Time: 100’ of Pipe	Time: 200’ of Pipe	Time: 300’ of Pipe	Time: 400’ of Pipe
4	1:53	1:53	1:53	1:53
6	2:50	2:50	2:50	2:51
8	3:47	3:47	3:48	5:04
10	4:43	4:43	5:56	7:54
12	5:40	5:42	8:33	11:24
15	7:05	8:54	13:21	17:48
18	8:30	12:49	19:140	25:38
21	9:55	17:27	26:11	34:34
24	11:24	22:48	34:11	45:35

27	14:26	28:51	43:16	57:41
30	17:49	35:37	53:25	71:13

2) Record the drop in pressure during the test period. If the air pressure has dropped more than 0.5 psig during the test period, the line is presumed to have failed. IF the 0.5 psig air pressure drop has not occurred during the test period, the test shall be discontinued and the line will be accepted.
3) If the line fails, determine the source of the leakage, make corrections and retest. The Contractor has the option to test the section in incremental stages until the leaks are isolated. After the leaks are repaired, retest the entire section between manholes.

8. Deflection Testing
   a. Perform vertical ring deflection testing on all portions of the PVC piping, in the presence of the Design Professional, after backfilling has been in place for at least 30 days but not longer than 12 months.
   b. The maximum allowable deflection for installed ductile iron sewer pipe shall be limited to 5.0% of the original vertical internal diameter.
   c. Perform deflection testing with deflectometer, calibrated television, or a properly sized "Go, No-Go" mandrel. The mandrel(s) shall be subject to the approval of the Design Professional.
   d. Pipe exceeding the allowable deflection shall be located, excavated, replaced and retested at the sole expense of the Contractor.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 TEMPORARY BYPASS PUMPING

A. The Contractor is required to furnish all materials, labor, equipment, power, maintenance, etc. to implement a temporary bypass pumping system for the purpose of diverting the existing flow around the work area. Bypass pumping system shall be sized to match the capacity of the sewer main.

B. The bypass pumping system shall have sufficient capacity to pump all anticipated average, peak day, and peak hour flows plus additional flows that may occur during a storm event.

C. All equipment shall be designed and manufactured for sanitary sewer service, shall function acceptably, be reliable, and free from leaks or other deleterious environmental impacts. All equipment proposed for use in bypass pumping shall have been maintained per the manufacturer's recommendations. Equipment service records shall be made available at the Borough's request. Any hoses or pipes that leak shall be removed and replaced with non-leaking hoses or pipes.

3.11 CLEANING

A. Clean dirt and superfluous material from interior of piping.

B. The work area shall be restored to its original or better condition.

END OF SECTION 221313

SECTION 223000 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Domestic Hot Water Circulators

B. Grease Interceptors.

C. Instantaneous Water Heaters

1.2 SUBMITTALS

A. Product Data:

1. Indicate pump type, capacity, power requirements.
2. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
3. Provide electrical characteristics and connection requirements.

B. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer. Warranty shall begin after final payment.

1.3 QUALITY ASSURANCE

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

B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 DELIVERY, STORAGE, AND HANDLING

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

1.5 EXTRA MATERIALS

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

1.6 OWNER INSTRUCTION/DEMONSTRATION

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

PART 2 PRODUCTS

2.1 IN-LINE CIRCULATOR PUMPS

A. Manufacturers:

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

2.2 GREASE INTERCEPTOR (ALTERNATE BID)

A. Manufacturers:

1. Schier

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

B. Kitchen Grease Interceptor (GI-1):

1. Description: Seamless, rotationally molded high-density polyethylene tank with minimum 3/8 inch uniform wall thickness. Interceptor shall be engineered for above or below grade installation. Interceptor shall be built in accordance to ASME A112.14.3 (type C) with field adjustable riser system, and built in flow control. Interceptor grease capacity shall be at least four times its rated flow (GPM). Cover shall provide water/gas tight seal and have minimum H20/HS20 load capacity.
2. Capacity:
   a. Flow: 100 GPM
   b. Grease capacity: 1,751 lbs.
   c. Solids: 21 gallons.
   d. Liquid: 275 gallons.
3. Grease interceptor shall have third party certification to ASME grease interceptor standard #A112.14.3
4. Interceptor shall be supplied with built in adaptor for up to 6" lid riser adjustability. Additional risers shall be available for deeper burial depths (Contractor shall verify exact requirements in field).
5. Interceptor cover placement shall provide full access to tank for proper maintenance.
6. Interceptor shall have integral air relief/anti-siphon.
7. Interceptor shall be equipped with 4" no-hub connections for inlet and outlet.

8. Lifetime warranty: Interceptor shall be lifetime guaranteed and Made in USA.
9. H20 rated relieving pad – Site Contractor shall provide H20 concrete relieving pad. Refer to Plumbing drawings and manufacturers details for design and minimum dimensions of relieving pad. Relieving pad shall be sloped to prevent ponding of water on relieving pad and at access covers. P.C. shall coordinate all pad details/grades with site construction in field, prior to beginning any work.
10. Anchor Kit - All interceptors installed below grade shall be provided with ant-flotation anchor kit where water table can exceed lowest level of installation.
11. Basis of Design: Schier Products Great Basin GB-250 - 100 GPM, 275 liquid gallons, 1,751 lbs. grease capacity.

2.4 INSTANTANEOUS POINT-OF-USE WATER HEATERS

A. Manufacturers

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

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

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

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

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

F. Cover: UL rated 94 Vo.

G. Mounting: Bracket or device for wall mounting.

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

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

J. Schedule

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

PART 3 EXECUTION

3.1 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Coordinate with plumbing piping and related electrical work for each piece of equipment to achieve operating system.

C. Recirculation Pumps:

1. Refer to Detail on Plumbing Drawings for pump installation information and associated piping accessories.
2. Provide circuit setter valve set to specified flow.
3. Install circulation pumps in orientation as required by manufacturers recommendations.
4. Coordinate power wiring to pump and aqua stat controls with E.C. in field.
5. Set programmable timer as directed by Owners Maintenance representative.

D. Grease Interceptor

1. Install grease interceptor in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification.
2. Provide venting of downstream piping as required by local Authority Having Jurisdiction.
3. Exterior Installations (Below Grade):
    a. Verify inverts for all below grade/below slab grease interceptors prior to beginning any work.
    b. Plumbing Contractor shall provide H-20 rated concrete relieving pad and heavy duty rated access covers as noted on plumbing drawings and details.
    c. Provide access covers extended to grade. Verify required height of access cover extensions in field prior to order of grease interceptor unit. Final height of access covers shall allow grade to slope away from access covers and prevent ponding of water at access covers. Coordinate grades and slopes with site contractor to prevent ponding of water prior to beginning any work.
    d. Provide manufacturers recommended anti-flotation device where water table could exceed lowest level of grease interceptor installation.

END OF SECTION 223000

SECTION 223400 - FUEL-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Gas fired domestic water heaters.
2. Water heater accessories.

B. Related Section: Following Division 22 Sections contain requirements that relate to this Section:

1. Section 22 0519, “Meters and Gages for Plumbing Piping”
2. Section 22 0548, “Vibration and Isolation for Plumbing Piping and Equipment"
3. Section 22 0553, “Identification for Plumbing Piping and Equipment”
4. Section 22 0719, “Plumbing Piping Insulation”
5. Section 22 1005, “Plumbing Piping”
6. Section 22 1006, “Plumbing Piping Specialties”

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, finishes and coatings, required clearances, methods of assembly of components, and piping and wiring connections.

C. Product Options: Drawings indicate size, profiles, connections, dimensional requirements, and characteristics of water heaters and accessories and are based on specific types and models indicated.

D. Setting Drawings with templates and directions for installing foundation bolts, anchor bolts, and other anchorages.

E. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between factory-installed and field-installed wiring.

F. Product certificates signed by manufacturers of water heaters certifying that their products comply with specified requirements.

G. Certificates of shop inspection and data report as required by provisions of ASME Boiler and Pressure Vessel Code, when ASME construction is indicated.

H. Maintenance data for water heaters to include in operation and maintenance manuals specified in Division 01. Include startup instructions.

1.4 CERTIFICATIONS

A. AGA Standards: Comply with AGA standards and bear AGA (CSA International) certification label.

B. ASME Boiler and Pressure vessel code, section IV, Part HLW

C. ANSI Z21.10.3 /CSA 4.3 “Gas Water Heaters”

D. ASHRAE/IES 90.1

E. DOE/EPA Energy Star

F. ISO 9001 Quality Management System

G. CSD-1 “Controls and Safety Devices for Automatically Fired Boilers”

H. NFPA 70- National Electric Code

I. NFPA 54- National Fuel Gas Code

J. NSF/ANSI Standard 61- Drinking Water System Components

K. NSF/ANSI Standard 372 – Drinking Water System Components – Lead Content

L. NSF 5 – Water Heaters, Hot Water Supply Boilers and Heat Recovery Equipment

M. ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

1.5 QUALITY ASSURANCE

A. Listing: The water heater will be listed ETL listed to UL 795 or ANSI Z21.10.3/CSA 4.3 “Gas Water Heaters”

B. ASME Compliance: Water heater shall bear the ASME HLW stamp and be National Board listed

C. Water heaters with full rated input between 199,000 and 300,000 BTU will operate at a minimum 95.3% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).

D. The water heater will comply with current ASHRAE 90.1 requirements.

E. Water heater manufacturer certified to the ISO 9001 International Quality System.

1.6 WARRANTY

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

B. Warranty period shall begin at date of final inspection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Commercial, High-Efficiency, Down-Fired Powered-Burner Design, Low-NOx, Power Vent, Gas Water Heaters:
1. Bradford-White Corp.
2. Laars
3. Rheem Triton
4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.

B. The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses as established for gas fired water heaters.

2.2 CONSTRUCTION

A. Specified manufacturer's standard components and features are acceptable where specific product requirements are not indicated.

B. Temperature Control: Adjustable thermostat, except for units where other arrangement is indicated or temperature is regulated by flow-control fitting.

C. Safety Control: Automatic, high-temperature-limit cutoff device or system on commercial units and where indicated. Include automatic low-water cutoff device or system on commercial units where indicated.

D. Interior Finish: Materials that comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.

E. Tappings: Factory fabricated of materials compatible with tank. Include tappings for piping connections, relief valves, pressure gage, thermometer, blow down, CPVC vent, and controls as required and others as indicated. Attach tappings to tank before testing and labeling. Include tappings and connections as follows:
1. 2-Inch NPS (DN50) and Smaller: Threaded ends.
2. 2-1/2-Inch NPS (DN65) and Larger: Flanged ends.

F. Insulation: Fiberglass, polyurethane foam, or manufacturer's standard that is suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls.

G. Jacket: Steel, with baked-on enamel finish, except where otherwise specified.

H. Anode Rods: Factory installed, magnesium.

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

A. Description: ASHRAE/IES 90.1-1999, commercial, storage, powered-vent, high efficiency gas water heater; with capacity more than 40 gal. and natural-gas input more than 75,000 Btuh.

B. Storage Tank Construction: ASME labeled, steel with 150-psig working-pressure rating.

C. Meets or exceeds SCAQMD R1146.2 low NOx requirements.

D. Burner: Manufacturer's standard, for use with powered-vent water heaters and natural-gas fuel.

E. Gas Shutoff Valve: ANSI Z21.15, manually operated. Furnish for installation in piping.

F. Pressure Regulator: ANSI Z21.18, factory or field installed, for gas appliances. Provide regulators with pressure rating, capacity, and pressure differential required for water heater and gas supply.

G. Automatic Ignition: ANSI Z21.20, automatic gas-ignition system and components.

H. Automatic Valve: ANSI Z21.21, appliance, automatic gas valve.

I. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 and ANSI Z21.22. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.

J. Inlet and Outlet Manifolds: Fabricated by water heater manufacturer and capable of providing balanced flow through water heaters, for multiple-unit installation.

K. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 and ANSI Z21.22. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.

L. Advanced Electronic Controls: Microprocessor controls ignition and thermostat, with adjustment of water temperature from 100 deg. F to 180 deg. F.

M. Basis of Design: Bradford White EF Series Ultra High Efficiency Water Heaters
   1. DWH-1 (Building Hot Water Supply): EF-100T-199E-5NA (Qty.2)
      a. Storage capacity: 100 gal. (ea.)
      b. Gas input: 199,999 BTU (ea.)

c. Recovery: 235 gal./hr@100F (ea.)
d. First Hour Delivery: 309 gal. (ea.)
e. Vent Piping: Sch. 40 PVC
f. Air Intake Piping: Sch. 40 PVC
g. Accessories:
   1) Expansion Tank - Amtrol Model ST-12-C, 4.7 gallons., ASME Construction

2.4 OPTIONS: TO BE PROVIDED

A. Condensate neutralization system

B. Vent Termination Kit

C. Installation Kit

D. Factory Authorized Startup

PART 3 - EXECUTION

3.1 CONCRETE BASES

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

3.2 WATER HEATER INSTALLATION

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

B. General: Install water heaters on concrete bases. Set and connect units according to manufacturer's written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturer's recommended clearances. Install so controls and devices are accessible for service.

C. Anchor water heaters and storage tanks to substrate.

D. Install seismic restraints as required by IBC and as specified.

E. Install and connect gas water heaters in accordance with IFGC 2018 and NFPA 54.

   1. Install appropriately sized gas pressure regulator on gas-burner inlets. Coordinate gas inlet pressure with plumbing drawings and water heater gas supply pressure with manufacturer prior to order/installation.
   2. Install vent piping from gas burner pressure regulators and valves to building exterior in accordance with IFGC. Terminate vent piping with brass-screened vent cap fitting. Do not combine vents except with approval of authorities having jurisdiction.

F. Install temperature and pressure relief valves in top portion of storage water heater tanks and

hot-water storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.

G. Install pressure relief valves in hot-water-outlet piping for water heaters without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.

H. Install vacuum relief valves in cold-water-inlet piping.

I. Install vacuum relief valves in water heaters and hot-water storage tanks that have copper lining.

J. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Section 221006 "Plumbing Piping Specialties" for drain valves.

K. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Section 220519 "Meters and Gages for Plumbing Piping"

L. Install pressure gages on water heater inlet and outlet piping. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping"

M. Install piping adjacent to water heaters to allow service and maintenance.

N. Arrange for field-applied insulation on equipment and piping not furnished with factory-applied insulation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Connect hot- and cold-water piping to units with shutoff valves and unions. Where indicated, connect hot-water circulating piping to unit with shutoff valve, check valve, and union.
2. Connect gas piping to gas burner with drip leg, tee, shutoff valve, and union; minimum size same as inlet connection. Gas piping is specified in Section 221006 "Plumbing Piping."
3. Make connections with dielectric fittings where piping is made of dissimilar metals. Dielectric fittings are specified in Section 221006 "Plumbing Piping Specialties."

B. Electrical Connections: Power wiring and disconnect switches are specified in Division 26 Sections. Arrange wiring to allow unit servicing.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.

1. Test/adjust operating/safety controls. Replace damaged/malfunctioning controls/equipment.
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Review data in the operation and maintenance manuals. Refer to Division 01 Section "Contract Closeout".
4. Review data in the operation and maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
5. Schedule training with the Owner with at least 7 days advance notice.

B. Perform the following final checks before startup:

1. Fill water heaters with water.
2. Charge expansion tanks with air.
3. Check that piping system tests are complete.
4. Check for piping connection leaks.
5. Check for adequate combustion air.
6. Check for clear vents and devices.
7. Check for clear relief valve inlets, outlets, and drain piping.
8. Check operation of pumps and circulators.
9. Test operation of safety controls, relief valves, and devices.

C. Perform the following startup procedures:

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

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electric Water Coolers

B. Emergency Eyewash

C. Lavatories

D. Laundry Tub

E. Mop Receptors

F. Sinks.

G. Urinals

G. Water Closets

1.2 RELATED REQUIREMENTS

A. Division 07 - Joint Sealers: Seal fixtures to walls and floors.

B. Section 22 1005 - Plumbing Piping.

C. Section 22 1006 - Plumbing Piping Specialties.

D. Section 22 3000 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2004.

B. ARI 1010 - Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; Air-Conditioning and Refrigeration Institute; 2002.

C. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).

D. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.

E. ASME A112.19.2 - Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals; The American Society of Mechanical Engineers; 2003.

F. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 2005.

G. ICC/ANSI A117.1-2003 - Accessible and Usable Buildings and Facilities; 2003

H. IBC2018 - ICC - International Building Code; 2018

I. IPC2018 - ICC - International Plumbing Code; 2018

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

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturer's data for all Plumbing Fixtures specified herein and on the Plumbing Drawings. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.

C. Maintenance Data: Submit maintenance data including installation instructions, routine maintenance instructions, spare parts lists, and exploded assembly views for each plumbing fixture. Include this data in Maintenance Manual.

D. Review of submittals which do not clearly indicate the information noted above may be delayed or Rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review.

E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer. Warranty period shall begin after final payment.

1.5 QUALITY ASSURANCE

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

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

B. Plumbing Fixtures shall be manufactured and installed in accordance with standards set forth in IPC. Where "Accessible" fixtures are required, the fixture shall be manufactured and installed in accordance with ICC/ANSI A117.1.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY

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

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

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

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

PART 2 - PRODUCTS

2.1 FIXTURES AND MANUFACTURED PRODUCTS:

A. General: Provide factory-fabricated fixtures and equipment recommended by the manufacturer for use in the service indicated.

B. Fixture Manufacturers:

   1. All items specified herein shall be manufactured by the manufacturer listed or other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 1 specifications for additional information.

2.2 ELECTRIC WATER COOLERS - REFER TO DRAWINGS FOR LOCATIONS.

A. Electric Water Cooler Manufacturers:

   1. Halsey Taylor.
   2. Elkay.
   3. Oasis.
   4. Haws.
   4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. (EWC-1) SURFACE MOUNTED, BI-LEVEL BARRIER FREE ELECTRIC WATER COOLER W/ BOTTLE FILLING STATION:

   1. Water Cooler: Electric, mechanically refrigerated; surface mounted with; stainless steel basin with Real Drain, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, vandal resistant front push button, wall mounting bracket; integral air cooled condenser, with water filter.
   2. Bottle Filling Station: Sensor Activated, visual filter monitor, green counter, laminar flow antimicrobial
   3. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
   4. Electrical: 115V, 60Hz, 4.0Amps chiller, manufacturer provided cord and plug electrical connection

5. Accessories: Sch.40 PVC p-trap, wheel handle quarter turn stop with flexible hose supply. Provide dielectric fittings where required by manufacturer's installation instructions. Provide cane touch skirt where required for compliance with ADA/ANSI A117.1 requirements for protruding objects.
6. ADA/ANSI A117.1 compliant for juvenile
7. Basis of Design:
   a. Halsey Taylor; Model HTHB-HVRGRN8BL-WF

2.3 EMERGENCY EYEWASH

A. Manufacturers:

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

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

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

2.4 LAVATORIES

A. Manufacturers:

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

d. Zurn Industries, Inc: www.zurn.com.
e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

B. (LAV-1) LAVATORY, WALL HUNG-ELECTRONIC SENSOR FAUCET - (Gang Toilet Rooms, except Gym Gang Toilets & Nurse) Refer to Drawings for locations.

1. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20 by 18 inch minimum, with 4-inch-high back, rectangular basin with splash lip, front overflow, and soap depression. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
   a. Drilling Centers: 4 inch.
   b. Basis of Design: American Standard Inc; Lucerne 0355.012, 20" x 18", wall hung, drilled for concealed arm carrier system
2. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
   a. Spout Style: Standard.
   b. Power Supply: 24 VAC.
      1) Direct wired to junction box.
      2) For 24V applications, provide above ceiling mounted transformer and all low voltage wiring from transformer to faucets/flush valves. Power wiring to transformer shall be provided by the E.C.
   c. Water Supply: 3/8-inch compression connections.
   d. Aerator: Vandal resistant, 0.5 GPM.
   e. Finish: Polished chrome.
   f. Basis of Design:
      1) Sloan Valve Company: Model Optima Series ETF-600-BDT-EL154
3. Accessories:
   a. Mixing Valve: Below deck thermostatic tempering valve that meets ASSE 1070 standard.
   b. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
   c. Offset waste with perforated open strainer.
   d. Screwdriver/loose key quarter-turn chrome plated angle stops.
   e. Flexible copper or braided stainless-steel supplies as applicable.
   f. Truebro Lav Shield - Custom factory precut, PVC, China white, w/stainless steel wall anchors, ANSI A117.1 compliant and installed in accordance with ANSI A117.1 requirements. Locate all equipment/accessories associated with the electronic faucet and the mixing valve within this shield.
4. Carrier:
a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

C. (LAV-2) LAVATORY, WALL HUNG - MANUAL FAUCET - (Faculty Toilets, Kitchen Toilet) Refer to Drawings for locations.

1. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20 by 18 inch minimum, with 4-inch-high back, rectangular basin with splash lip, front overflow, and soap depression. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
   a. Drilling Centers: 4 inch.
   b. Basis of Design: American Standard Inc; Lucerne 0355.012, 20" x 18", wall hung, drilled for concealed arm carrier system.

2. Manual Operated Faucet: Solid Cast brass, chrome plated, deck mounted.
   a. Spout Style: Standard.
   b. Controls: Single Lever ADA compliant chrome plated metal handle
   c. Water Supply: 3/8-inch compression connections.
   d. Aerator: Vandal resistant, 0.5 GPM.
   e. Mixing Valve: Integral thermostatic mixer meeting ASSE 1070 to 0.5gpm minimum flow
   f. Finish: Polished chrome.
   g. Basis of Design:
      1) Powers TempTap P1070A5
      2) Watts Lavsafe: P1070
3. Accessories:
   a. Chrome plated 17-gauge brass P-trap with clean-out plug and arm with escutcheon.
   b. Offset waste with perforated open strainer.
   c. Screwdriver/loose key quarter-turn chrome plated angle stops.
   d. Flexible copper or braided stainless-steel supplies as applicable.
   e. Truebro Lav Shield - Custom factory precut, PVC, China white, w/stainless steel wall anchors, ANSI A117.1 compliant and installed in accordance with ANSI A117.1 requirements. Locate all equipment/accessories associated with the mixing valve within this shield.
4. Carrier:
   a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

D. (LAV-3) LAVATORY, WALL HUNG - MANUAL FAUCET - (Principal) Refer to Drawings for locations.

1. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20 by 18 inch minimum, with 4-inch-high back, rectangular basin with splash lip, front overflow, and soap depression. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
   a. Drilling Centers: 4 inch.
   b. Basis of Design: American Standard Inc; Lucerne 0355.012, 20" x 18", wall hung, drilled for concealed arm carrier system
2. Manual Operated Faucet: Solid Cast brass, chrome plated, deck mounted.
   a. Spout Style: Standard.
   b. Controls: Single Lever ADA compliant chrome plated metal handle
   c. Water Supply: 3/8-inch compression connections.
   d. Aerator: 1.5 GPM.
   e. Mixing Valve: Integral thermostatic mixer meeting ASSE 1070 to 0.5gpm minimum flow
   f. Finish: Polished chrome.
   g. Basis of Design:
      1) Powers TempTap P1070A15
      2) Watts Lavsafe: P1070
3. Accessories:
   a. Chrome plated 17-gauge brass P-trap with clean-out plug and arm with escutcheon.
   b. Offset waste with perforated open strainer.
   c. Screwdriver/loose key quarter-turn chrome plated angle stops.
   d. Flexible copper or braided stainless-steel supplies as applicable.

e. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84

4. Carrier:
   a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

D. (LAV-4) LAVATORY, COUNTERTOP - MANUAL FAUCET - (Gym Toilets) Refer to Drawings for locations.

1. Vitreous China Self-Rimming Basin: ASME A112.19.2; vitreous china self-rimming lavatory, ADA compliant, 16 inch wide by 10 inch front to back, 5-5/8" deep with front overflow and faucet ledge. Refer to the Architectural Interior Elevation Plans.
   a. Drilling Centers: 4 inch.
   b. Basis of Design: American Standard Inc; Aqualyn 0476.028, 16" x 10" countertop lavatory
2. Manual Operated Faucet: Solid Cast brass, chrome plated, deck mounted.
   a. Spout Style: Standard.
   b. Controls: Single Lever ADA compliant chrome plated metal handle
   c. Water Supply: 3/8-inch compression connections.
   d. Aerator: Vandal resistant, 0.5 GPM.
   e. Mixing Valve: Integral thermostatic mixer meeting ASSE 1070 to 0.5gpm minimum flow
   f. Finish: Polished chrome.
   g. Basis of Design:
      1) Powers TempTap P1070A52)
      2) Watts Lavsafe: P1070
3. Accessories:
   a. Chrome plated 17-gauge brass P-trap with clean-out plug and arm with escutcheon.
   b. Offset waste with perforated open strainer.
   c. Screwdriver/loose key quarter-turn chrome plated angle stops.
   d. Flexible copper or braided stainless-steel supplies as applicable.
   e. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with valance).

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

A. Manufacturers:

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

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

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

2.6 JANITOR'S SINK (MR-1)

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

B. Manufacturers:

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

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

1. Basin: 36in. x 36 in. terrazzo drop front mop sink, 3" integral drain, with flanges
   a. Basis of Design: Florestone Model 91
2. Faucet: Chrome plated cast Brass, integral vacuum breaker, pail hook, wall support
   a. Basis of design: Delta Commercial, Model 28C2383
   b. Install check valves on hot and cold water supplies to faucet.
3. Accessories
   a. Wall Guards: Florestone Model MR-377 (2) 36" Stainless Steel.
   b. Mop Hanger: Florestone Model MR-372 with 3 grips on stainless steel wall bracket.
   c. Hose Hanger: Florestone Model MR-370 with 36" hose and wall hanger.
4. Provide and install cold water hose bibb adjacent to janitor's sink assembly. Hose Bibb shall be Woodford model 101C with 1/2"sweat fitting inlet, 3/4" male hose thread outlet connection, integral vacuum breaker, and patented check, adjustable polycarbonate wall flange. Install with drop front toward service side.

2.7 SINKS - Refer to drawings for locations.

A. Manufacturers:

1. Sink:

a. Just Manufacturing Co.: www.justmfg.com.
b. Elkay Corporation: www.elkayusa.com.
c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

2. Supply Faucet:
   a. Chicago Faucet, Inc Commercial Faucets:
   b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

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

1. Sink: ASME A112.19.3; 20” by 22” by 5-1/2” inch outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch) and right/left side bubbler. Verify "Standard and ADA-Accessible" sink requirements and locations with Architectural Interior Elevation Plans prior to rough in.
   a. Drain: 3-1/2 inch all metal crumb cup and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl
   b. Basis of Design:
      1) ADA- Just Manufacturing; Model CRB-ADA-2022-A-GR (5-1/2" Deep, Center-Rear Drain)
2. Faucet: ASME A112.18.1; chrome plated brass supply with high rise 8.0" rigid/swing spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
   a. Basis of Design: Chicago #1100-GN8AE35VP-317AB
3. Bubbler: Sink mounted bubbler unit, Elkay Model LKBH1141A with cold water provided from sink supply, with in-line shut-off valve.
4. Accessories: Chrome plated 17-gauge brass tailpiece with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies as applicable.
5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).

C. (SINK-2) Single Compartment Bowl – (Nurse/Health Exam Room)

1. Sink: ASME A112.19.3; 18” by 15” by 5-1/2” inch outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch).
   a. Drain: 3-1/2 inch all metal crumb cup and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl
   b. Basis of Design:
      1) Just Manufacturing; Model SL-ADA-1815-A-GR (5-1/2" Deep, Center Drain).
2. Faucet: ASME A112.18.1; chrome plated brass supply with high rise 5-1/4" rigid/swing spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
   a. Basis of Design:
      1) Chicago #1100-GN2AE35VP-317AB
3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies as applicable.
4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008

Section 3.5, ASTM E84 (Not required with Valance).

D. (SINK-3) - Single Compartment Bowl w/Eyewash: - (Health)

1. Sink: ASME A112.19.3; 19” by 21” by 5-1/2” inch outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch).
   a. Drain: 3-1/2 inch all metal crumb cup and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl
   b. Basis of Design:
      1) Just Manufacturing; Model SL-ADA-1921-A-GR (5-1/2" Deep, Center-Rear Drain)
2. Faucet: ASME A112.18.1; chrome plated brass supply with high rise 8.0" rigid/swing spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
   a. Basis of Design:
      1) Chicago #1100-GN8AE35VP-317AB
3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies as applicable.
4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).
5. Provide w/Sink mounted drench hose eyewash unit: Haws model 8904 deck mounted with dual 45-degree angled heads with caps and SP212 vacuum breaker. Provide below deck, mounted thermostatic mixing valve to supply tepid water to eyewash unit; Powers model ES-150-11 with hot/cold water provided off sink supplies, with in-line shut-off valves.

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

1. Sink: ASME A112.19.3; 19” by 21” by 5-1/2” inch outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch).
   a. Drain: 3-1/2 inch all metal crumb cup and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl
   b. Basis of Design:
      1) Just Manufacturing; Model SL-ADA-1921-A-GR (5-1/2" Deep, Center-Rear Drain)
2. Faucet: ASME A112.18.1; chrome plated brass supply with high rise 8.0" rigid/swing spout, water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
   a. Basis of Design:
      1) Chicago #1100-GN8AE35-317AB
3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies as applicable.
4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).

F. (SINK-5) - Single Compartment Bowl – (Faculty Dining)

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

drilled for trim (4-hole punch).
a. Drain: 3-1/2 inch all metal crumb cup and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl
b. Basis of Design:
1) Just Manufacturing; Model SL-ADA-1921-A-GR (5-1/2" Deep, Center-Rear Drain)

2. Faucet: ASME A112.18.1; chrome plated brass supply with 10 in. swivel spout, water economy aerator with maximum 1.5 gpm flow, 4" lever handle, ceramic cartridge, with side spray, ADA compliant.
a. Basis of Design:
1) Chicago #2301-8E34ABCP

4. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies.

5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).

G. (SINK-6) - Single Compartment Bowl – (Art Room – ADA):

1. Sink: ASME A112.19.3; 21" by 25" by 5-1/2" inch outside dimensions (ADA), 18 gage thick, Type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim (3-hole punch). Verify "Standard and ADA-Accessible" sink requirements and locations with Architectural Interior Elevation Plans prior to rough in.
a. Drain: 3-1/2 inch all metal crumb cup and tailpiece. (ADA units shall be provided with drain outlet centered-rear in bowl.
b. Basis of Design:
1) ADA- Just Manufacturing; Model SL-ADA-2125-A-GR (5-1/2" Deep, Center-Rear Drain)

2. Faucet: ASME A112.18.1; chrome plated brass supply with high rise 8.0" rigid swing spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, ADA compliant.
a. Basis of Design:
1) Chicago #1100-GN8AE35VR-317AB

3. Accessories: Chrome plated 17 gage brass tailpiece with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies as applicable.

4. Provide w/plaster trap. Refer to Plumbing Detail Drawings and specification section 221006 for additional installation requirements.

5. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84 (Not required with Valance).

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

1. Sink: Stainless steel commercial work sink; 74" by 23 13/16" by 12" bowl depth, 16 gage, 300 series stainless steel, with ledge back drilled for trim (2-hole punching), (2) 18" drain boards, 1 5/8" diameter galvanized steel legs.
a. Drain: (2) 3-1/2 inch all metal basket strainer and tailpiece.
b. Basis of Design:
1) Elkay #2C18x18-2-18X-CT-1 (30" Special Working Height)

2. Faucet: chrome plated brass supply with 8" centers and 12" L-type swing spout, 2.2 gpm, Quaturn compression cartridge w/lever handles, low lead.

a. Basis of Design:
1) Chicago #540-LDL12ABCP

3. Accessories: Chrome plated 17 gage brass tailpiece with escutcheon, screwdriver/loose key chrome plated quarter-turn stops, flexible copper or braided stainless-steel supplies as applicable.
4. Provide w/plaster trap. Refer to Plumbing Detail Drawings and specification section 221006 for additional installation requirements.

I. (SINK-8) Hand Sink – (Kitchen)

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

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

1. Sink: NSF approved; overall dimensions 72 in. x 30 in. x 36 in high, single compartment 16 in. x 20in. x 10" deep sink bowl on left, radius corners, 18 gage thick, 304 series stainless steel, 6in. back splash, Custom 8" o.c. deck mount faucet holes, basket drain, adjustable stainless steel undershelf and stainless steel legs with stainless steel adjustable bullet feet.
   a. Drains: (1) drain w/basket strainer and tailpiece included with sink.
   b. Basis of Design:
      1) BK Resources; Model BKPT-3072S-L
      2) Elkay: Model LK50-8980
2. Faucet: ASME A112.18.1; NSF/ANSI 61 & 372, chrome plated, L type swing spout, 1.5 gpm aerator, lever handles, 8" centers.
   a. Basis of Design:
      1) Chicago, Model 1100-L9E35ABCP

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

1. Sink: NSF approved; overall dimensions 114in. x 31in. x 37.5 in high, 3-compartments 24in. x 24in. x 14" deep, 5/8" coved radius tub corners, Left & Right drain boards 24in. width, 14 gage thick, 300 series stainless steel, 9-1/2in. back splash drilled for trim (2-hole punch – 2 required), raised rolled edges, legs are stainless steel tubing with stainless steel adjustable feet. Provide optional lever drain.
   a. Drains: (3) 3-1/2- inch drains w/basket strainer and tailpiece and optional lever drain.
   b. Basis of Design:
      1) Eagle Group; Model FN2472-3-18-14/3

2. Faucet: Pre-rinse faucet, chrome plated, ASME A112.18.1; NSF/ANSI 61 & 372, 8" body with quaturn compression cartridges and lever handles, 3/8" offset inlet supply arms with integral check valves, 1.0 gpm spray valve, riser with spring guide, 44in. flexible Stainless Steel hose with insulated handle, pipe strap and hook assembly. Secondary faucet: chrome plated, L type swing spout including quaturn cartridge with lever handle and full flow outlet.
   a. Basis of Design:
      1) Chicago #510-G613L15XKCAB (2 required).

2.8 URINALS

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

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

2) For 24V applications, provide above ceiling mounted transformer and all low voltage wiring from transformer to faucets/flush valves. Power wring to transformer shall be provided by the E.C.

c. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.

d. Basis of Design:

1) Sloan Valve Company; Model Optima Series 186-0.5-ES-S TMO, EL-154 transformer and all necessary low voltage cables for complete installation: www.sloanvalve.com.

3. Carriers:

a. ASME A112.6.1M; compact adjustable cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

B. (UR-2) URINAL - WALL HUNG- MANUAL FLUSH VALVE (Gym Toilet Room) Refer to drawings for locations.

1. Urinal: Vitreous china, ASME A112.19.2, washout style, wall hung with side shields and concealed carrier. Mount at standard and ADA height units as designated on Architectural Interior Elevation Plans.

a. Flush Volume: 0.5 gallon, maximum.

b. Flush Style: Washout.

c. Flush Valve: Exposed (top spud).

d. Flush Operation: Manual

e. Trap: Integral.

f. Removable stainless steel strainer.

g. Supply Size: 3/4 inch.

h. Outlet Size: 2 inches.

i. Basis of Design:

1) American Standard Inc; Model Washbrook 6501.010, wall hung, top spud

2. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.

a. Manual-Operated Type: Oscillating, non-hold open handle.

b. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.

c. Flush Volume: 0.5 GPF.

d. Basis of Design:

1) Sloan Valve Company: Model Royal 186-0.5: www.sloanvalve.com.

3. Carriers:

a. Existing carrier to remain.

2.9 WATER CLOSETS

A. Manufacturers (All Water Closets)

1. Bowl:

a. American Standard Inc: www.americanstandard.com.

b. Kohler Company: www.kohler.com.

c. TOTO USA, Inc.: www.totousa.com

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

2. Flush Valves:

a. Sloan Valve Company: www.sloanvalve.com.

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

3. Seats:

a. Bemis Manufacturing Company: www.bemismfg.com.

b. Church Seat Company: www.churchseats.com.
c. Olsonite: www.olsonite.com.
d. Zurn industries, Inc: www.zurn.com.
e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

4. Carriers:
a. JOSAM Company: www.josam.com.
b. J.R. Smith Company: www.jrsmith.com.
c. Mifab Drainage Products
d. Zurn Industries, Inc: www.zurn.com.
e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner. Refer to Division 01 specifications for additional information.

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

1. Bowl: Vitreous china with EverClean, ASME A112.19.2, elongated rim, wall hung, siphon jet flush action, bolt caps. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
a. Flush Volume: 1.6 gallon, maximum.
b. Flush Valve: Exposed (top spud).
c. Flush Operation: Sensor operated.
d. Supply Size: 1-1/4 inches.
e. Outlet Size: 4 in.
f. Basis of Design:
1) American Standard Inc; Model Afwall 3351.101 wall hung, elongated, top spud with Permanent EverClean antimicrobial surface.

2. Flush Valve: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
a. At all accessible locations coordinate rough in dimensions with grab bar locations prior to rough in.
b. Sensor-Operated Type: Solenoid operator, low voltage hard-wired, infrared sensor and True Mechanical Over-ride push button on valve body.
c. Exposed Type: All Chrome plated, sweat solder adapter with cover tube and cast wall flange, 1" screwdriver angle stop w/vandal resistant stop cap.
d. Power Supply: 24 VAC.
1) Direct wired to junction box.
2) For 24V applications, provide above ceiling mounted transformer and all low voltage wiring from transformer to faucets/flush valves. Power wiring to transformer shall be provided by the E.C.
e. Basis of design:
1) Sloan Valve Company; Model 111-1.6-ES-S TMO, EL-154 transformer and all necessary low voltage cables for complete installation
2) Substitutions: See Division 01 - Product Requirements.

3. Seats:
a. Solid white plastic, antimicrobial, open front, extended back, stainless steel self-sustaining hinge, brass bolts, without cover.

4. Water Closet Carriers:
a. ASME A112.6.1M; adjustable compact cast iron frame, integral drain hub and vent, metal nipple assembly, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. Provide horizontal and vertical drain units as required by installation methods.

C. (WC-2) - WATER CLOSET, MANUAL OPERATED FLUSH VALVE, WALL HUNG - (Faculty, Principal and Gym Toilets) Refer to Drawings for locations.

1. Bowl: Vitreous china with EverClean, ASME A112.19.2, elongated rim, wall hung, siphon jet flush action, china bolt caps. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
   a. Flush Volume: 1.6 gallon, maximum.
   b. Flush Valve: Exposed (top spud).
   c. Flush Operation: Manual operated.
   d. Supply Size: 1-1/4 inches.
   e. Outlet Size: 4 in.
   f. Basis of Design:
      1) American Standard Inc; Model Afwall 3351.101 wall hung, elongated, top spud with Permanent EverClean antimicrobial surface.
2. Flush Valve: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   a. At all accessible locations coordinate rough in dimensions with grab bar locations prior to rough in.
   b. Manual-Operated Type: Oscillating non-hold open operator, chloramine resistant, Permex synthetic rubber diaphragm, filtered bypass, vacuum breaker
   c. Exposed Type: All Chrome plated, sweat solder adapter with cover tube and cast wall flange, 1" screwdriver angle stop w/vandal resistant stop cap.
   d. Basis of design:
      1) Sloan Valve Company; Model Royal 111-1.6
3. Seats:
   a. Solid white plastic, antimicrobial, open front, extended back, stainless steel self-sustaining hinge, brass bolts, without cover.
4. Water Closet Carriers:
   a. ASME A112.6.1M; adjustable compact cast iron frame, integral drain hub and vent, metal nipple assembly, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. Provide horizontal and vertical drain units as required by installation methods (Connect to existing carriers for Gym Toilet Rooms).

D. (WC-3) - WATER CLOSET, MANUAL OPERATED FLUSH VALVE, FLOOR MOUNTED (Kitchen Toilet Room) Refer to Drawings for locations.

1. Bowl: Vitreous china with EverClean, ASME A112.19.2, elongated rim, floor mounted, siphon jet flush action, china bolt caps, ADA Compliant.
   a. Flush Volume: 1.6 gallon, maximum.
   b. Flush Valve: Exposed (top spud).
   c. Flush Operation: Manual operated.
   d. Supply Size: 1-1/4 inches.
   e. Outlet Size: 4 in.
   f. Basis of Design:
      1) American Standard Inc; Madera FloWise, 16-1/2” Height, Model 3461.001 floor mounted, elongated, top spud with Permanent EverClean antimicrobial surface.
2. Flush Valve: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   a. At all accessible locations coordinate rough in dimensions with grab bar locations prior to rough in.

b. Manual-Operated Type: Oscillating non-hold open operator, chloramine resistant, Permex synthetic rubber diaphragm, filtered bypass, vacuum breaker
c. Exposed Type: All Chrome plated, sweat solder adapter with cover tube and cast wall flange, 1" screwdriver angle stop w/vandal resistant stop cap.
d. Basis of design:
1) Sloan Valve Company; Model Royal 111-1.6

3. Seats:
a. Solid white plastic, antimicrobial, open front, extended back, stainless steel self-sustaining hinge, brass bolts, without cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

D. PREPARATION

1. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture "Plumbing Fixture List" for particular fixtures.

2. Verify location of "Accessible" fixtures with Architectural drawings and verify mounting requirements for all "Accessible" fixtures in accordance with ICC/ANSI 117.1. Prior to rough-in.

E. INSTALLATION
1. Install fixtures, materials and equipment in accordance with manufacturer's written instructions, roughing in drawings and details on the drawings.
2. Install all "Accessible" Fixtures in accordance with ICC/ANSI 117.1.
3. Install each fixture with trap, easily removable for servicing and cleaning.
4. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
5. Install components level and plumb.
6. Install and secure fixtures in place with concealed wall carriers and bolts or secure to floor or countertop as appropriate. Unless noted otherwise concealed carriers shall be bolted securely to the floor.
7. Seal fixtures to wall and floor surfaces with sealant as specified in Division 07, color to match fixture.

F. INTERFACE WITH WORK OF OTHER SECTIONS

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

G. ADJUSTING

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

H. CLEANING

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

I. PROTECTION

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

J. SCHEDULES

1. Fixture Rough-In
   a. Water Closet (Flush Valve Type):
      1) Cold Water: 1 1/4 inch.
      2) Waste: 4 Inch.
      3) Vent: 2 Inch.
   b. Lavatory:
      1) Hot Water: 1/2 Inch.
      2) Cold Water: 1/2 Inch.
      3) Waste: 1-1/2 Inch.
      4) Vent: 1 1/2 inch.
   c. Sink:
      1) Hot Water: 1/2 Inch.
      2) Cold Water: 1/2 Inch.
      3) Waste: 2 inch.
      4) Vent: 2 inch.
   d. Janitors Sink / Service Sink:
      1) Hot Water: 1/2 Inch.
      2) Cold Water: 1/2 Inch.
      3) Waste: 3 inch.
      4) Vent: 2 inch.
   e. Electric Water Cooler:
      1) Cold Water: 1/2 Inch.
      2) Waste: 1-1/2 Inch.
      3) Vent: 1-1/2 Inch.
   f. Emergency Eye Wash drench hose):
      1) Hot Water: 1/2 Inch to tempering valve.
      2) Cold Water: 1/2 Inch to tempering valve.
      3) Tempered Water: 1/2 Inch from tempering valve to unit

END OF SECTION 224000

SECTION 230501 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE:

A. Provide a complete and operating HVAC system in accordance with these specifications and accompanying contract drawings. This shall include all required labor, materials, equipment, and supervision.

B. Work shall include but is not limited to the following systems, equipment, materials, and labor for a complete system including the following:

1. Ductwork
2. Air Handlers
3. Unit Ventilators
4. Diffusers, grilles, and registers
5. Exhaust fans and relief vents.
6. Air-cooled chiller
7. Hot water, chilled water, refrigerant, and condensate piping systems
8. Terminal heating equipment
9. Automatic temperature control system
10. Boilers
11. Pumps
12. Rooftop units
13. Energy recovery units.

C. Where the contract drawings and specifications reference the Mechanical Contractor (M.C.), the work shall be performed by the H.V.A.C. Contractor (H.C.). The references may be used interchangeably.

1.2 DRAWINGS:

A. Drawings are part of the bid documents and are intended to show approximate and relative locations of services and equipment. they shall not be scaled to determine exact positions, locations, and clearances.

B. Due to the diagrammatic layout and small scale of the drawings, certain piping and duct rises, drops, offsets, valves, and related specialties are not shown. The contractor shall provide all ductwork, piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the owner.

C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical, and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to consult other trades, this Contractor shall rearrange his work at his own expense.

1.3 FIRE UNDERWRITER SEAL:

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

1.4 CONCRETE AND MASONRY WORK:

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

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

1.5 ANCHOR BOLTS:

A. Each Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished by him under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.

B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.

C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.6 SLEEVES:

A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.

B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be one pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe.

C. Sleeves for pipes passing through non-fire rated floors: 18 gage galvanized steel.

D. Sleeves for pipes passing through non-fire rated beams, walls, footings, and potentially wet floors: Steel pipe or 18 gage galvanized steel.

E. Sleeves for rectangular ductwork: Galvanized steel

F. Firestopping for non-plastic piping, ductwork shall be 3M, Dow, Corning fire caulk/packing or accepted equivalent. Refer to Division 7. Install steel angles around duct penetrations.

G. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.

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

1.7 ESCUTCHEONS:

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

1.8 ACCESS DOORS AND PANELS:

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

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

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

1.9 CLEANING OF SYSTEMS:

A. The Contractors shall thoroughly clean all pipe and ductwork systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.

B. All strainers shall be opened and cleaned thoroughly.

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

D. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.10 INSTRUCTION TO EMPLOYEES:

A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.

B. Three copies of factory maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.

C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.11 SUBSTITUTIONS:

A. Various items of equipment and materials that have been used as the basis for mechanical system design have been specified by a manufacturer's name and model number. Another manufacturer’s product may be submitted for consideration as a substitute. The Architect shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each of the Contractor's substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation. It shall be the responsibility of the Contractor to make certain that substitute equipment, which has been accepted by the Architect will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing. Substitutions include all manufacturers that are not listed specifically by name on the drawings, even those listed as “approved equals” in the specifications.

1.12 ALTERNATES:

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

1.13 ALIGNMENT:

A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.

B. The Mechanical and Electrical Contractors shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.14 TEMPORARY HEAT:

A. Requirements for providing temporary heat are stated in the General Conditions of the Specifications. New HVAC equipment furnished under this Contract may be used for temporary heat provided all of the following conditions are met:

1. The HVAC equipment is installed as part of the permanent HVAC systems as indicated on the Drawings.
2. The Contractor unconditionally extends the manufacturer's warranty one year from the date of final acceptance by the Owner.
3. Air Handling systems, including air handlers, fan-powered boxes, etc. and duct distribution systems are not to be utilized for temporary heat until interior construction is substantially complete as determined by the Engineer. Obtain approval in writing.
4. The manufacturers of units with compressors extend the 5 year compressor warranty to start from the date of final acceptance by the owner.

1.15 RULES AND REGULATIONS

A. All work shall be performed in accordance with the rules and regulations of Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.

B. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.

C. The Owner will obtain the building permit. Any other fees relative to the contractors work shall be paid by the contractor as part of his Bid.

1.16 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT, AND MATERIALS

A. The Contractor shall submit, with a letter of transmittal to the Architect, PDF file type shop drawings containing all capacities, performances, features, options, accessories and technical data of all materials and equipment listed herein. All submittals shall be made within 45 days after awarding of the contract.

B. Refer to Division 1.

C. All disapproved submittals shall be corrected as directed by the Architect and resubmitted until approved within 30 days after the original submittal was disapproved. No work involving any materials or equipment covered by shop drawings shall be started until the respective shop drawings are approved.

D. None of the items listed under Section 1.02 shall be installed until final approval has been given by the Architect.

E. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number and specification section number, as appropriate on shop drawings.

F. On shop drawings, apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Work and Contractor Documents.

G. On shop drawings, provide space for Contractor and Architect/Engineer review stamps.

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

1.17 VISIT TO THE SITE

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

1.18 COORDINATION OF WORK

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

1.19 LOCATION OF EQUIPMENT

A. All locations of plumbing, HVAC and fire protection equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.

B. The Mechanical Contractor shall prepare dimensioned coordination/arrangement drawings at a scale of (1/4” = 1'0”). Layouts represented by these drawings shall be coordinated with all other trades.

C. This Contractor shall obtain Architect approval of all arrangement drawings before continuing his work.

1.20 MATERIALS AND EQUIPMENT

A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.

B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on this project. Samples shall be submitted for approval Architect prior to their installation.

C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.21 WORKMANSHIP

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

1.22 PROTECTION OF EQUIPMENT

A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.

B. He shall schedule material and systems for delivery in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.

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

1.23 SCAFFOLDING AND HOISTING

A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.

B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.24 FOREMAN

A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.

B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.25 EXCAVATION AND BACKFILL

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

B. Backfill shall be made with clear earth; free from rocks, frozen earth, debris, or other foreign materials. Backfill shall be deposited in uniform layers of not over 8" thick and each layer shall be mechanically tamped before the next layer is applied.

C. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.

D. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.

E. All ditching, pumping, canvas covers, and other methods required to protect and keep all excavation and trenches free from water at all times during the construction period shall be furnished, installed, and maintained by the Contractor.

F. If the trench bottom becomes muddy, all mud shall be removed and replaced by bankrun sand and gravel or other suitable material as approved by Architect, and compacted to the density of the surrounding undisturbed soil. Bottom of trench shall be protected against frost or freezing. This Contractor shall provide adequate shoring to protect his and other workmen. Shoring shall be maintained until tests of lines is completed.

G. Trenches that pass under paving or roads have less than 2' of cover, shall have a load-relieving slab over the pipe. Trenches which pass under or within 18" of any wall foundation shall be backfilled with concrete mixes 1 part cement, 3 parts sand, and 5 parts coarse aggregate.

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

I. All grading and seeding made necessary by work done under this contract shall be performed by the Site Contractor at the expense of this Contractor. Work shall comply with the Architectural Section of the Specifications.

1.26 PAINTING

A. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted 1 prime coat and 2 coats of best quality oil pain of color as selected by the Architect.

B. All grilles, louvers, etc. shall be furnished in a color as selected by the Architect unless specifically noted otherwise on the mechanical drawings and schedules. When requested by the Architect, the equipment shall be finished with a prime coat and then professionally painted in the field in a color selected by the Owner. The Contractor shall assume responsibility for all costs involved.

C. All exposed ductwork and piping systems shall be paint-grip type and painted with a prime coat by the H.C. The G.C. shall provide finishing coat(s). All exposed piping systems shall be painted by the contractor installing the pipe.

D. Provide corrosion inhibiting prime coating on all ferrous materials.

E. Paint all metal laid underground with one heavy coat of corrosion protective materials.

1.27 CUTTING AND PATCHING

A. This Contractor shall be responsible for all cutting and patching required for installation of new work on this project. Cutting and patching methods shall conform to the requirements for new construction contained in other sections of this specification.

B. Patching in surfaces that will remain visible when the project is finished shall be identical in appearance to the undisturbed surface and shall be performed by the G. C.

C. Patches in fire rated walls, ceilings and floors shall maintain the fire rating of these barriers by the use of approved materials including special fire rated sealing compounds or material identical to the barrier materials. Refer to the Architectural Specifications for approved methods and materials.

D. All cutting work to existing walls, floors and ceiling sin occupied areas during a phase prior to construction in that area shall be patched in time to be occupied during the hours of the next school day.

E. Contractor shall seal all ductwork and piping penetrations through walls and floors even if not fire rated.

1.28 CLEANING

A. Upon completion of the installation, thoroughly purge all piping of all piping of all obstruction and scale and adequately flush all liquid carrying piping to assure a clean system. Flush and treat all systems in each phase as required to meet phasing requirements.

B. Wash all fixtures with soap and water, remove labels and protective covering and clean all grease and cutting from plates or polished piping and trim.

C. Where damage to finish, furnishing or parts of the building results from pipe stoppage or from failure to clear and flush piping systems properly, the Contractor shall at his own expense, employ qualified skilled labor to make repairs.

1.29 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall prepare for the Owner, 3 hard bound volumes, each containing all operating instructions and information necessary for the care and maintenance of the system. These volumes shall be complete in every respect, and shall include detailed operating instructions for each piece of equipment and diagrams for control wiring and piping so arranged and detailed that the maintenance staff may trace the control in even operational malfunctioning.

B. The Contractor shall submit 1 of the hard bound volumes to the Architect for approval prior to presenting same to Owner.

C. Printed instructions covering the operating and maintenance of each item of equipment shall be posted at locations designated by the Architect.

D. The Contractor shall provide Project Records Documents in accordance with requirements of Division 1.

1.30 INSTRUCTION OF EMPLOYEES

A. At the completion of the work this Contractor shall instruct the employees who shall have charge of the equipment in the care, adjustment, and operational of all parts of the system.

B. At the time designated by the Architect, the equipment manufacturer's engineer shall instruct representatives of the Owner in the operation and maintenance of the equipment.

1.31 GUARANTEE

A. All work done under these contracts shall be guaranteed by the respective contractors against defective materials and faulty workmanship for a period of 2 years from the date of substantial completion.

B. During such a period, and before the expiration of each such guarantee, contractor shall agree to make any and all repairs, adjustments, or replacements which may become necessary, owning to initial settlement or shrinkage, defective material, workmanship, or installation. He shall perform all routine maintenance in accordance with the equipment manufacturer requirements.

C. He shall further agree to provide all labor and material which may be required and to restore to its original condition any adjacent work that he may disturb in making the necessary repairs, adjustments, or replacements in order to fulfill this guarantee.

D. Compressors shall have a 5 year guarantee.

1.32 GENERAL NOTE

A. The HVAC Contractor shall replace filters in all new air handlers, rooftop units, unit ventilators, and cabinet heaters at the date of final completion of each phase. Up until that time, filters in all units shall be changed as necessary if the units are started and used prior to end of the phase. Provide a schedule of recommended filter change intervals and filter sizes for all equipment to the Owner, and review locations of all filters with the Owner's custodial and maintenance staff prior to turn over of each phase.

PART 2 – PRODUCTS

2.1 NOT USED

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install equipment to permit removal of components and parts which require periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, gauges, starters, motors, doors and access panels.

B. Provide access panels in equipment, ducts, etc. as required for inspection and maintenance.

3.2 PIPING INSTALLATION

A. In general, piping shall be exposed in equipment rooms, and concealed in all finished rooms. Where piping is exposed, it shall be run so as to allow maximum headroom consistent with proper pitch. No piping or ductwork shall cross below the head of any window or door.

B. Exposed piping, ducts, conduits, and/or appurtenances indicated on the inside of buildings, shall be installed parallel to the building lines. All piping shall be kept as close as possible to the ceilings, walls, and columns, to take up the minimum amount of space.

C. All work shall be arranged and installed as high as possible to prevent obstruction of window areas, and to give adequate clearance and access for operation and maintenance.

3.3 SLEEVES

A. Where pipes pass through concrete or masonry walls or concrete floors, they shall be protected through the full depth of the construction with galvanized sleeves; same to be at least one size larger than the pipe plus insulation.

B. Where sleeves occur in concrete floors, the top of sleeve shall be flush with finished floor line, and the end shall be filed to a smooth round finish.

C. This Contractor shall supply all pipe sleeve and shall inform general contractor of exact sleeve locations in time for their incorporation onto the concrete forms or masonry work.

D. Any cutting and patching in masonry or concrete made necessary by failure to adequate coordinate with the general contractor shall be done by the general contractor at the expense of this contractor.

E. The space between pies and sleeves shall be caulked air tight with a non-combustible inorganic material.

3.4 UNIONS

A. Unions shall be provided at all connections to each piece of equipment and on both sides of all automatic valves, and devices which requires removal for maintenance. No unions are to be placed in a location which will be inaccessible after the completion of the project.

B. Unions of copper tubing shall be 200 lbs. SWP brass ground joint.

C. Unions for steel pipe shall be 250 lbs. SWP, malleable iron with brass to iron seat.

3.5 CLEARANCE

A. All piping, including valves and fittings shall be installed to provide the following minimum clearances between the finish coverings, adjacent pipe and/or conduits: 2” between for piping services and 6” between piping services and electrical conduits.

B. All soil, vent and waste stacks shall be increased to a minimum of 3" in size immediately before such pipes extend through the roof. Unless noted otherwise on drawings, all stacks extending through the roof shall finish at least 12" above the roof level.

C. Furnish and install absorbers where required for proper system operation.

3.6 ESCUTCHEON PLATES

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

3.7 ACCESS PANELS

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

B. Access panels in finished wall or ceiling surfaces shall be furnished by this Contractor for installation by the General Contractor.

C. This Contractor shall pay for any work made necessary by his failure to inform other trades of access panel locations.

3.8 APPLICATIONS OF INSULATION AND COVERING

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

3.9 PIPING UNDER FLOORS

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

3.10 INSERTS

A. Except as noted, provide box type inserts for all hangers and supports intended to suspend piping or light weight equipment from new concrete construction. Fasten all inserts of the form work before concrete is poured. Inserts to be Grinnell Figure No. 282 or Figure No. 279 depending upon the maximum load to be carried.

B. No toggle bolts, expansion screw anchors or similar imbedded hanger supports shall be used in new construction.

3.11 CHASES AND OPENINGS IN FLOORS AND WALLS

A. It shall be the duty of the Contractor requiring chases, openings or the placement of any sleeves, anchors, and supports required for his work, whether or not shown on the drawings, to advice the General Contractor accordingly, prior to or at the time of pouring concrete slabs, beams or the building of walls, etc. He shall furnish all such sleeves, anchors, and supports in place, and all necessary information for the proper location f said chases or openings.

B. If a contractor shall fail to observe and comply with those requirements, he shall cut, at his own expense, after receiving the consent of the Architect, such chases or opening as may be necessary and proper, providing and building in place all lintels required by these openings, doing the necessary patching and rebuilding of the work required under the direction of the General Contractor and he hall be responsible for all loss or delay resulting therefrom.

3.12 LUBRICATION

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

3.13 EQUIPMENT BASES AND SUPPORTS:

A. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

B. Construct supports of steel members. Brace and fasten and flanges bolted to structure.

C. Provide rigid anchors for pipes after vibration isolation components are installed.

END OF SECTION 230501

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single phase electric motors.

B. Three phase electric motors.

1.2 RELATED SECTIONS

A. Section 23 0514 - Adjustable Frequency Drives.

1.3 REFERENCES

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.

C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

D. ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.

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

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

E. Operation Data: Include instructions for safe operating procedures.

F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.5 QUALITY ASSURANCE

A. Conform to NFPA 70.

B. Motors shall comply with ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings current edition.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Century

B. Baldor

C. Lincoln Motors

D. A. O. Smith Electrical Products Company

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Construction:

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

B. Provide motors with phase loss protection.

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

D. Insulation shall be Class B. Motors shall be drip-proof in dry, non-hazardous locations, weather protected where exposed to the weather or dampness, and totally enclosed, fan cooled where specified. Drip-proof and totally enclosed fan cooled motors, fractional and integral horsepower, shall have service factor ratings of 1.15 and 1.0 respectively. Fractional horsepower motors shall have sealed, permanently lubricated, ball bearings unless sleeve bearings are standard with a manufacture of equipment which utilized direct driven fans. Integral horsepower motors shall have ball bearings with grease 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.

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

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

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

H. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

I. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

J. Wiring Terminations:

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

2.3 ELECTRICAL CONNECTIONS

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

2.4 MOTOR CONTROLLERS

A. Mechanical Contractor shall provide motor controllers. The items shall be products of one manufacturer, Allen-Bradley, Square D, General Electric or Westinghouse, and shall meet latest N.E.M.A. and IEEE Specifications. Starters and contactors shall be horsepower rated. Starters shall include the proper size heater elements

B. Magnetic starters used with pressure or float switches, thermostats or similar maintained contact switches shall be provided with "On-Off-Auto" switches on the starter.

C. Unless otherwise noted, control and pilot devices such as electric thermostats, alternators, float controls, aquastats, etc., shall be furnished and installed by the Mechanical Contractor. Each device shall be provided with all auxiliary features and accessories which may be required for correct operation of the associated equipment.

D. Magnetic starters shall be provided with start-stop pushbuttons on the starters unless remote control pushbuttons or other methods of starting are specified elsewhere.

E. Unless otherwise noted elsewhere, all magnetic motor starters controlled with a remote pilot device shall contain a control circuit transformers, as an integral part of the controller, providing control power at a maximum 120 volts for the pilot device. The exact control circuit voltage shall be coordinated with the ATC supplier prior to the purchase of any motor controllers.

F. Starters and protective devices which are provided as an integral part of the equipment furnished under the Mechanical Contracts, shall be supplied.

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

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

2.5 MOTOR DISCONNECTS:

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

B. All exhaust and supply fans on the roof shall be provided with disconnecting means at the motors as an integral part of the equipment.

2.6 ENCLOSURES:

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

2.7 MOTOR CONTROL WIRING:

A. The Electrical Contractor shall run the power wiring system from the various supply panels indicated, to the motors and motor controllers and shall make final connections unless otherwise noted on the Drawings. The Mechanical Contractors shall run all control wiring from the motor controllers to the pilot devices.

B. Starters, and protective control devices which are provided as integral part of the motors or motor-operated equipment shall be prewired at the factory.

C. After final connections are completed, the Mechanical Contractor shall test each motor for proper rotation. Before applying current to the motor, the Mechanical Contractor shall check the motor for alignment, oil, etc. The Mechanical Contractor shall make any necessary adjustments to the starter and control equipment for proper starting and overload protection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

D. All electrical work provided by this contractor shall comply with the electrical contract specifications.

E. Motors:

1. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
2. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 230513

SECTION 230514 - ADJUSTABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The General Provisions of the Contract, including General and Supplementary Conditions apply to the Work of this Section.

B. Section 23 0993 - HVAC Control Sequence.

C. Section 23 0923 – Automatic Temperature Controls

1.2 DESCRIPTION OF WORK:

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

1.3 QUALITY ASSURANCE:

A. Manufacturers: Subject to compliance with the requirements of this section, provide adjustable frequency drives as manufactured by Magnatek, Square D, Cutler Hammer, ABB, or Danfoss.

B. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 70 "National Electric Code", pertaining to the construction and installation of electrically operated components.

C. NEMA Compliance: Comply with applicable provisions of NEMA Standards pertaining to motor starters, control panels, and wiring devices.

D. UL Compliance: Provide electrical components which have been tested, approved, and labeled by Underwriters Laboratories.

1.4 SUBMITTALS:

A. Division 1contains definitions, requirements and procedures for the following submittals:

1. Shop Drawings
2. Guarantees
3. Product Data

1.5 WARRANTY:

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

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES:

A. General: Provide adjustable frequency drives (AFD) for equipment as scheduled to vary the speed of the three phase AC motors to proportionately control the air flow of each system. The

AFD shall utilize a 16-bit microprocessor for sine-coded pulse width modulation of AC induction or synchronous motors.

B. Input Power: The AFD shall accept 208V/3P/60Hz (or as scheduled) input voltage within a ±10% variation.

C. Output Power: The AFD output power shall vary frequency to the motor from 0 to 400 Hz with resultant motor speed varying at the motor nameplate rated speed, with output voltage variation from zero to motor rated voltage for optimum volts per hertz (V/Hz) ratio for fan loads. Output currents shall be rated 125% of motor full load amps for 1 minute based upon AFD's variable torque rating. The output shall be a voltage source type generating a sine coded PWM waveform utilizing an asynchronous carrier frequency up to 15000 Hz. The carrier frequency shall be adjustable to minimize harmonically induced noise or vibration.

D. Power Structure: The AFD power input stage shall convert three phase AC line power to a fixed DC bus voltage by using a full-wave diode rectifier with three phase protection. Power factor shall be .98 or corrected with capacitors. The AFD shall have power component monitoring/protection, short circuit power protection, and capacitive filtering of DC power. Switching transistors shall convert DC power to sine coded pulse width modulation voltage for motor control. Current transformers shall monitor output current and be used by the microprocessor for: thermal overload protection, three phase current limit, ground fault and short circuit protection, and motor restart with speed search. Insulated Gate Bipolar Transistors shall be utilized for a fixed carrier frequency of 15,000 Hz.

E. Operation and Protective Functions: The AFD shall be capable of performing the following operational functions in addition to providing built-in protective features:

1. DC injection braking with adjustable start frequency, current limit and time duration to provide braking before fan start-up.
2. Programmable critical frequency interruptive to lock-out up to 3 frequency ranges, 0 to 10 Hz, to avoid motor operation at resonant speeds.
3. Speed search to restart motor while fan is still rotating.
4. Reference speed loss detection to continue fan operation if the reference frequency is interrupted. Motor shall be operated at 80% of last reference 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.

F. Control Terminal Functions: A control terminal strip shall be provided to accept the following external control commands:
1. Forward Run/Stop to initiate or stop AFD operation.
2. Speed Reference Input to accept an instrument follower signal of either a) 0 to 10 VDC, b) 4 to 20mA, or c) 1 to 5 VDC as determined by the Automatic Temperature Control Contractor.

G. Multi-function output contacts programmable for any of the following indications:

1. Run mode
2. Zero speed detect
3. Over-torque detect
4. Coast to stop detect
5. Run reference mode
6. Speed reference mode
7. Speed synchronization
8. Output frequency detect
9. Low voltage detect
10. Operation ready
11. Speed reference loss detect
12. Braking resistor fault
13. Drive fault
14. Output fault relay contact to indicate AFD diagnostic fault detection.
15. Terminal for HOA switching.
16. Input terminal to shut down motor operation on smoke detection signal or other external fault signals.
17. Analog output signal, 0 to 10 VDC, proportional to output frequency or output covered.

H. Local Operator Control: The AFD shall have a front mounted sealed touch-pad operator to include:

1. Local run/stop keys
2. Local speed command
3. Reset push button
4. Digital output frequency meter and speed reference meter which both can be reprogrammed for other speed related indications, including RPM, CFM, FPM, etc.
5. Digital voltmeter.
6. Digital kilowattmeter.
7. Digital ammeter.
8. Input and output terminal status indication.
9. Ability to program various control functions without necessity of stopping drive while in Run mode, including but not limited to the following:
    a. Acceleration and deceleration
    b. Frequency command bias and gain
    c. Torque compensation
    d. Slip compensation
    e. Energy savings gain
    f. Multi-step speed references
    g. Digital diagnostic indication and protection for:
        1) DC bus undervoltage
        2) DC bus over voltage
        3) Load over torque
        4) Fuse blown
        5) Motor overload
        6) AFD overload
        7) Heatsink over temperature

8) Instantaneous over current
9) Operator error
10) Central processor fault
11) External fault
12) Dynamic braking fault

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

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

J. Bypass: The VFD shall have a bypass to allow operating the connected motor in the event of VFD failure.

K. Systems Integration: AFD manufacturer shall provide Lon Works and BACNET network card to interface with BAS system.

PART 3 - EXECUTION

3.1 INSTALLATION:

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

3.2 START-UP:

A. Do not place AFD's into start-up until mechanical and electrical systems are fully operational including installation of terminal equipment and automatic temperature controls.

B. The AFD manufacturer's factory trained service personnel shall perform all programming and start-up procedures.

C. Instruct Owner on operation of unit. Provide minimum 4 hours instruction.

3.3 TESTING AND ADJUSTING:

A. The manufacturers factory trained service personnel shall test each unit through the full range of operation including checking all input/output signals, and fault conditions.

B. Manufacturer shall validate system is fully functional and operation perfectly upon completion of testing and adjusting.

END OF SECTION 230514

SECTION 230515 - REMOVALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION OF WORK:

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

1.3 GENERAL:

A. Existing piping, fixtures, equipment, ductwork and related accessories which require systems to be shut-down shall be coordinated with the Owner. Periods of shut-down shall be minimal and all new work shall be planned and scheduled to accomplish as few shut-downs as possible.

B. All construction and removal work shall be performed in a manner as to keep the existing systems in operation as the work progresses. Prior to commencing construction, the contractor shall review the construction schedule with the Owner and Architect to assure a well-coordinated schedule.

C. Cutting and patching in concealed locations shall be by this Contractor unless otherwise indicated.

D. Cutting and patching in exposed locations shall be by the General Contractor.

E. The Owner shall have the option of keeping any or all salvageable items removed from building such as draft barriers, unit ventilators, cabinet heaters plumbing fixtures, etc. Any items removed from the building that Owner does not wish to keep shall become the property of this Contractor and he shall dispose of these items.

F. Boiler Removal:

1. This contractor shall be responsible for boiler removal, including any required asbestos abatement for the sectional sealing ropes. Contractor shall contract with an asbestos removal consultant and asbestos removal contractor to prepare an asbestos abatement plan and removal.

END OF SECTION 230515

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Flexible pipe connectors.

B. Pipe loops, offsets, and swing joints.

1.2 RELATED REQUIREMENTS

A. Section 23 21 13 - Hydronic Piping.

B. Section 23 23 00 - Refrigerant Piping.

1.3 REFERENCE STANDARDS

A. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2013.

B. EJMA (STDS) - EJMA Standards; Expansion Joint Manufacturers Association; Ninth Edition.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

C. Design Data: Indicate selection calculations.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.

E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

F. Maintenance Data: Include adjustment instructions.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. Manufacturers:

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

B. Inner Hose: Carbon Steel.

C. Exterior Sleeve: Single braided, stainless steel.

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

E. Joint: As specified for pipe joints.

F. Size: Use pipe sized units.

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

2.2 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturer:

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

B. Inner Hose: Bronze.

C. Exterior Sleeve: Braided bronze.

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

E. Joint: As specified for pipe joints.

F. Size: Use pipe sized units.

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

2.3 EXPANSION LOOPS

A. Manufacturers:

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

4. Keflex.

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

C. Install witin 4 pipe diameters of alignment guide.

D. Pipe material shall match service pipe.

2.4 ACCESSORIES

A. Pipe Alignment Guides:

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

B. Swivel Joints:

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

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

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

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

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

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

END OF SECTION 230516

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1- GENERAL

1.1 SECTION INCLUDES

A. Pressure gages and pressure gage taps.

B. Thermometers and thermometer wells.

C. Static pressure gages.

1.2 RELATED SECTIONS

A. Section 23 21 13 - Hydronic Piping.

B. Section 23 09 23 - Automatic Temperature Controls.

C. Section 23 09 93 - HVAC Control Sequence.

1.3 REFERENCES

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2005.

B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi; The American Society of Mechanical Engineers; 2007.

C. ASTM E 1 - Standard Specification for ASTM Thermometers; 2007.

D. ASTM E 77 - Standard Test Method for Inspection and Verification of Thermometers; 2007.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

C. Project Record Documents: Record actual locations of components and instrumentation.

1.5 ENVIRONMENTAL REQUIREMENTS

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

B. Do not use mercury filled thermometers.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:

1. Moeller Instrument Co., Inc: www.moellerinstrument.com.
2. American.
3. Trerice.
4. Weksler.

B. Gage: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Steel with brass bourdon tube.
2. Size: 4-1/2 inch diameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Psi and KPa.

2.2 PRESSURE GAGE TAPPINGS

A. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.

B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

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

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

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

2.4 DIAL THERMOMETERS

A. Manufacturers:

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

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

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

2.5 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.

C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

D. Install thermometers in air duct systems on flanges.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 23 09 23. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

F. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

G. Coil and conceal excess capillary on remote element instruments.

H. Provide instruments with scale ranges selected according to service with largest appropriate scale.

I. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

J. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

K. Locate test plugs adjacent thermometers and thermometer sockets, pressure gauges and pressure gage taps, and where indicated.

END OF SECTION 230519

SECTION 230549 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SUMMARY:

A. The extent of vibration isolation work is indicated by Drawings and schedules and by requirements of this Section.

B. The types of vibration isolation specified in this Section include the following:

1. Support isolation for motor driven Mechanical Equipment.
2. Support isolation for piping and piping risers.
3. Flexible connections for piping at Equipment.
4. Flexible ductwork connections.

1.2 SUBMITTALS:

A. Comply with pertinent provisions of Division 1.

B. The Manufacturer of vibration isolation products shall submit the following data clearly marked on the submittal drawing. Each piece of isolated equipment shall be clearly identified, as well as the quantity and type of vibration isolators.

1. Weight and center of gravity of each piece of isolation equipment, and RPM of each piece of rotating isolated equipment. When equipment center of gravity is not available, assumed locations for center of gravity shall be identified in submittals.
2. Calculated static load on each isolator.
3. Calculated deflection for each piece of isolated equipment.

C. Submittals for mountings and hangers incorporating springs shall include spring diameters, rated deflections, spring free height, solid spring height and spring color code.

D. Submittals for bases shall clearly identify locations for all mountings, as well as all locations for attachment points of the equipment to be mounting base. Installation instructions shall be included.

1.3 QUALITY ASSURANCE:

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

1. Except as otherwise indicated obtain support isolation units from a single manufacturer.
2. Engage the manufacturer to provide technical supervision of the installation of support isolation units produced by him, and of associated inertia bases.

B. Manufacturer: Provide vibration isolation and seismic mounting units manufactured by the following:

1. Amber/Booth
2. Consolidated Kinetics Corp.
3. Vibration Mountings and Controls, Inc./Korfund Dynamics
4. Mason Industries
5. Vibration Eliminator Co.

C. After installation is complete and while the system is operating, the vibration isolation Manufacturer and/or his qualified Representative shall conduct an inspection of the installation with the Contractor. The Representative will submit a written inspection report detailing any discrepancies, the Representative shall submit a report so stating. If there are discrepancies, the report shall detail corrective work to be done.

1.4 DESIGN - VIBRATION ISOLATION SYSTEMS:

A. Vibration isolators shall be selected based on known or estimated operating weight distributions of the isolated equipment, with the quantity and location as shown on the components drawings. Isolator type shall be tabulated for each isolated piece of equipment.

B. Isolators shall have either known non-deflected heights of spring element or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified to determine if the load is within the proper range of the isolator and if the correct degree of vibration isolation is being provided.

C. Isolators shall function in the linear portion of the load versus deflection curve. Theoretical vertical natural frequency shall not differ from the design objectives by more than +10%.

D. Vibration isolation available internal to the equipment shall not be considered equivalent, and may only be used where it can be shown not to compromise the strength or performance of the entire system.

E. Unless otherwise specified, all isolated equipment and all piping and ductwork shall be seismically restrained in accordance with requirements contained herein. All un-isolated mechanical equipment shall be adequately secured to the structure.

F. Unless the equipment incorporates unit construction using an integral unit frame or is specified otherwise, each item of mechanical equipment, along with its drive unit, shall be mounted on a rigid steel or steel and concrete base. The equipment, including the base, shall be mounted on, or suspended from, vibration isolators to prevent the transmission of vibration and mechanically transmitted structure-borne sound to the supporting structure.

G. Isolation hangers shall be used for all piping in equipment rooms or for 50 ft. from vibration equipment, whichever is greater. To avoid reducing the effectiveness of equipment isolators, at least three of the first hangers from the equipment should provide the same deflection as the equipment isolators, with a maximum limitation of 2 inch deflection. The remaining hangers shall be spring or combination spring and rubber with a minimum of 0.75 in deflection. To prevent load transfer to the equipment flanges when the piping system is filled, the first three hangers adjacent to the equipment shall be the positioning type (specification type 5). Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use restrained vibration isolators. They should be selected according to the guidelines for hangers.

PART 2 - PRODUCTS

2.1 Unless otherwise specified, all hardware shall be stainless steel or zinc plated. Springs with a deflection of up to 2" shall be zinc plated or coated with a polyester epoxy powder. Springs with a rated deflection capability greater than 2" may be painted. Zinc plating shall conform to ASTM B633, Class 2 SC2, Minimum.

2.2 TYPE 1 MOUNTINGS - DOUBLE DEFLECTION NEOPRENE:

A. Double deflection neoprene mountings shall have a minimum rated static deflection of 0.40 inches. Steel top plate and base plate shall be completely bonded and embedded in oil-resistant elastomer. Mountings shall be molded in color for ease of identification of load capacity, and shall have ribbed neoprene surfaces on top and bottom to provide friction pads for those applications which do not need to be bolted to the floor or to equipment. Bolt holes shall be provided on the bottom plate, and a tapped hole on the top, for applications requiring positive tie down.

B. Mountings may be combined with steel rails for ease of installation, to compensate for overhung components or for equipment which lack sufficient rigidity for point support.

C. Neoprene mountings shall be type RD and steel channel rails type DRB as manufactured by Vibration Mountings and Controls, Inc.

2.3 TYPE 2 MOUNTINGS - FLOOR MOUNTED SPRING ISOLATORS:

A. Free standing spring-type isolators, shall be laterally stable without housing, snubbers, or guides, and shall include a steel reinforced, ribbed neoprene cup (1/4-inch minimum thickness) between the baseplate and the support.

B. Mountings shall have leveling bolts on the top, consisting of an adjusting bolt, cap screw and washer. Mountings shall include a bolt hole in the bottom cup or a two hole rectangular steel baseplate for bolting to the structure. Springs shall not be welded to the baseplate or cup.

C. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection.

D. Springs shall have a ratio of horizontal stiffness to vertical stiffness of .75 to 1.25.

E. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Springs having rated deflection greater than 2 inches may be painted. Hardware shall be stainless steel, or zinc plated.

F. Housed floor isolators shall consist of a telescoping housing containing one or more steel springs as the isolating medium. Isolators shall include resilient inserts to act as upper and lower housing guides, and to prevent metal-to-metal contact providing elastomeric snubbing for side loads. A replaceable neoprene acoustical non-skid pad shall be attached to the bottom of the housing. Mountings shall have built-in leveling bolts and a minimum additional travel to solid equal to 50% of the rated deflection.

G. Free standing Spring-Flex Mountings shall be Series AC, Series ACB, or Series AWHC as manufactured by Vibration Mountings and Controls, Inc. Housed Spring-Flex Mountings shall be Series B, C, or D as manufactured by Vibration Mountings and Controls, Inc.

2.4 TYPE 3 MOUNTINGS - HOUSED SPRINGS WITH LIMIT STOPS:

A. Free standing, laterally stable spring-type isolators. Isolators is the same as described in Specification Type 2, except that it includes a housing to provide vertical limit stops to prevent spring extension during weight changes (e.g., draining of fluid from cooling towers and boilers), or when equipment (such as cooling towers) are exposed to uplift loads such as wind loading.

B. The housing serves as blocking during erection, and shall be located between the equipment and supporting structure. Housing shall be painted or hot dip galvanized. There shall be a minimum clearance of 1/2 inch between the restraining bolts and the housing and spring to prevent interference with spring performance. Limit stops shall be out of contact during normal operation.

C. Mountings shall have an adjusting bolt on the top of the spring compression plate. Neoprene acoustical non-skid pads (1/4 inch minimum thickness) shall be attached to the bottom plate.

D. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection.

E. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Springs having rated deflection greater than 2 inches may be painted. Hardware shall be stainless steel or zinc plated. Springs shall not be welded to the cups or housings.

F. Spring-Flex Mountings shall be Series AWR as manufactured by Vibration Mountings and Controls, Inc.

2.5 TYPE 4 MOUNTINGS - SPRING AND RUBBER HANGERS:

A. Spring-Flex hangers shall consist of a steel spring in series with a .2 inch (minimum) deflection neoprene element. Springs shall be color coded, and elastomer element molded in specific colors for proper identification of rated load capacity. The total static deflection at rated load shall be 1.20 inches.

B. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

C. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

D. Spring-Flex hangers shall be series RSH as manufactured by Vibration Mountings and Controls, Inc.

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

A. Spring-Flex hangers shall consist of color-coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Hanger design shall incorporate a means for supporting the suspended equipment or piping at a fixed elevation during installation regardless of load changes as well as a means for transferring the load to the spring.

B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

C. Spring-Flex hangers shall be series RSHP positioning hangers as manufactured by Vibration Mountings and Controls, Inc.

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

A. Spring-Flex hangers shall consist of a color coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers which are to be used with flat iron duct straps will be provided with eye bolts on both ends.

B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

C. Spring-Flex hangers shall be Series RSH-30A as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be type RSHSC as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be type RSHSC as manufactured by Vibration Mountings and Controls, Inc.

2.8 TYPE 7 MOUNTINGS - PRE-COMPRESSED HANGERS:

A. Spring-Flex hangers shall consist of a color coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Springs shall be pre-compressed to the rated deflection so as to support the suspended equipment or piping at a fixed elevation during installation regardless of load changes. For 30 degree misalignment capability, spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box.

B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

C. Spring-Flex hangers shall be Series RSHPR or RSHPR-30A for 30 degree misalignment capability, as manufactured by Vibration Mountings and Controls, Inc.

2.9 TYPE 8 MOUNTINGS - SPRING HANGERS:

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

B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

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

2.10 TYPE 9 MOUNTINGS - HORIZONTAL THRUST RESTRAINTS:

A. Horizontal Thrust Restraints shall be provided to prevent excessive movement of air handling equipment having air thrust which exceeds 10% of the unit weight. The horizontal thrust restraint shall consist of a steel housing containing a steel spring in series with a neoprene pad. The restraint assembly shall be designed to be pre-adjusted by the manufacturer and permit further adjustment in the field to limit horizontal movement to a maximum of 1/4 inch. Assembly shall be furnished with back up plates and hardware for attachment to both the equipment and ductwork or structure. Horizontal restraints shall be attached on the centerline of thrust on each side of the unit.

B. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

C. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Hardware shall 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.

2.15 BASES AND RAILS:

A. TYPE C - CONCRETE INERTIA BASE:

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

B. TYPE D - ISOLATION ROOF CURB:

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

PART 3 - EXECUTION

3.1 PERFORMANCE OF VIBRATION ISOLATORS:

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

3.2 APPLICATIONS:

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

3.3 VIBRATION ISOLATOR SCHEDULE

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

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

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

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

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

3.4 INSTALLATION:

A. Isolation systems shall be installed in strict accordance with the Manufacturer's written instructions and submittal data. Locations of all vibration isolation products shall be selected for ease of inspection and adjustment, as well as for proper operation. Electrical and plumbing connections to vibration isolated equipment shall be flexible.

B. All vibration isolators shall be leveled and aligned squarely below the mounting points of the supported equipment. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft (generally, the long axis) unless this is not possible because of physical restraints.

C. Unless otherwise indicated, there shall be a minimum operating clearance of 1 inch between inertia bases or structural steel frames and the concrete housekeeping pad or floor beneath the equipment. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.

D. Vibration isolation hangers shall be positioned as high as possible in the hanger rod assembly, and so that the hanger housings may rotate a full 360 degrees without touching any object. Hanger rods shall not contact any object which would short out the vibration isolation systems. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Do not mix vibration isolated and non-vibration isolated pipes on the same trapeze.

E. Attention must be paid to movements of piping caused be expansion and contraction.

3.5 EXAMINATION OF RELATED WORK:

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

1. Equipment installations (performed as Work of other Sections) on vibration isolators.
2. Piping connections including flexible connections.
3. Ductwork connections including provisions for flexible connections.
4. Passage of piping and ductwork which is to be isolated through walls and floors.

B. Do not start up Equipment until inadequacies have been corrected in a manner acceptable to vibration isolation installer.

3.6 NOISE AND VIBRATION:

A. Particular care shall be exercised in the selection and installation of all Mechanical Equipment and components to attain reasonable noise levels in occupied spaces. In general, sound levels for various spaces shall be maintained in accordance with the recommendations of the ASHRAE Guide. Normally the classification of noise shall be by mutual agreement but should a dispute arise regarding sound levels after occupancy of the building, representative sound measurements shall be taken to determine the average noise level in the offending space.

B. Measurements shall be made with a calibrated sound meter, using the flat response network in decibels (db), and shall be taken first with doors and windows closed and Mechanical Equipment shut down. Upon completion of the measurements, the Mechanical Equipment shall be started and similar readings shall be taken. If the recorded increase is in excess of the maximum noise increases indicated in the following tabulation, suitable correction shall be made by the Contractor at no cost to the Owner.

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

3.7 CURB MOUNTED UNITS

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

END OF SECTION 230549

SECTION 230554 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION OF WORK:

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

1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.4 SUBMITTALS:

A. Product Data: Submit product specifications and installation instructions for each identification material and device required.

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification materials or system.

C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

PART 2 - PRODUCTS

2.1 MECHANICAL IDENTIFICATION MATERIALS:

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

B. Plastic Pipe Markers:

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

C. STENCILS

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

D. Valve Tags:

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

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

F. Valve Schedule Frames:

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

G. Engraved Plastic-Laminate Signs:

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

H. Manufacturer:

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

2.2 LETTERING AND GRAPHICS:

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or schedule. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Boiler No. 3, Air Supply No. 1H, Standpipe F12).

2.3 APPLICATION AND INSTALLATION:

A. General Installation Requirements:

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

B. Piping System Identification:

1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
    a. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
    b. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces.
3. Near each valve and control device.
a. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
4. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
5. At access doors, manholes and similar access points which permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
a. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. Valve Identification:

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

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

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

PART 3 - EXECUTION

3.1 MECHANICAL IDENTIFICATION:

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8” below finished grade, directly above buried pipe.

F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with stencil painting. Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify thermostats relating to terminal boxes or valves with nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4" diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20' on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. Identify ductwork with stenciled painting. Identify with air handling unit identification number and areas served.

N. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

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

END OF SECTION 230554

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic and refrigerating systems.

C. Measurement of final operating condition of HVAC systems.

D. Sound measurement of equipment operating conditions.

E. Vibration measurement of equipment operating conditions.

1.2 REFERENCE STANDARDS

A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.

B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2008.

C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau; 2005, Seventh Edition.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

1.3 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

1. Submit to Architect.
2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
4. Include at least the following in the plan:
    a. Preface: An explanation of the intended use of the control system.

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

w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
x. Procedures for formal progress reports, including scope and frequency.
y. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

1. Revise TAB plan to reflect actual procedures and submit as part of final report.
2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
3. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
7. Include the following on the title page of each report:
   a. Name of Testing, Adjusting, and Balancing Agency.
   b. Address of Testing, Adjusting, and Balancing Agency.
   c. Telephone number of Testing, Adjusting, and Balancing Agency.
   d. Project name.
   e. Project location.
   f. Project Architect.
   g. Project Engineer.
   h. Project Contractor.
   i. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

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

1. AABC MN-1, AABC National Standards for Total System Balance.

2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
4. SMACNA HVAC Systems Testing, Adjusting, and Balancing.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of three years documented experience.
3. Certified by one of the following:
   a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

F. Pre-Qualified TAB Agencies:

1. Optimum Performance Balancing.
2. H.T. Lyons.
3. Air Balancing Engineers, Inc.
4. Eastern Air Balance.
5. Mountain Air.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.

12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

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

3.6 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

3.7 SCOPE

A. Test, adjust, and balance the following:

1. HVAC Pumps
2. Boilers
3. Air Cooled Chillers
4. Air Cooled Refrigerant Condensers
5. Air Coils
6. Terminal Heat Transfer Units
7. Rooftop Air Handling & Recovery Units
8. Fans
9. Air Filters
10. Air Terminal Units
11. Air Inlets and Outlets

3.8 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer
2. Model/Frame
3. HP/BHP
4. Phase, voltage, amperage; nameplate, actual, no load
5. RPM
6. Service factor
7. Starter size, rating, heater elements
8. Sheave Make/Size/Bore

B. V-Belt Drives:

1. Identification/location
2. Required driven RPM
3. Driven sheave, diameter and RPM
4. Belt, size and quantity
5. Motor sheave diameter and RPM
6. Center to center distance, maximum, minimum, and actual

C. Pumps:

1. Identification/number
2. Manufacturer
3. Size/model
4. Impeller
5. Service

6. Design flow rate, pressure drop, BHP
7. Actual flow rate, pressure drop, BHP
8. Discharge pressure
9. Suction pressure
10. Total operating head pressure
11. Shut off, discharge and suction pressures
12. Shut off, total head pressure

D. Combustion Equipment:

1. Boiler manufacturer
2. Model number
3. Serial number
4. Firing rate
5. Gas pressure at meter outlet
6. Gas flow rate
7. Heat input
8. Percent carbon monoxide (CO)
9. Percent carbon dioxide (CO2)
10. Percent oxygen (O2)
11. Percent excess air
12. Flue gas temperature at outlet
13. Ambient temperature
14. Net stack temperature
15. Percent combustion efficiency
16. Heat output

E. Air Cooled Condensers:

1. Identification/number
2. Location
3. Manufacturer
4. Model number
5. Serial number
6. Entering DB air temperature, design and actual
7. Leaving DB air temperature, design and actual
8. Number of compressors

F. Chillers:

1. Identification/number
2. Manufacturer
3. Capacity
4. Model number
5. Serial number
6. Evaporator entering water temperature, design and actual
7. Evaporator leaving water temperature, design and actual
8. Evaporator pressure drop, design and actual

9. Evaporator water flow rate, design and actual

G. Cooling Coils:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Entering air DB temperature, design and actual
7. Entering air WB temperature, design and actual
8. Leaving air DB temperature, design and actual
9. Leaving air WB temperature, design and actual
10. Water flow, design and actual
11. Water pressure drop, design and actual
12. Entering water temperature, design and actual
13. Leaving water temperature, design and actual
14. Saturated suction temperature, design and actual
15. Air pressure drop, design and actual

H. Heating Coils:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Water flow, design and actual
7. Water pressure drop, design and actual
8. Entering water temperature, design and actual
9. Leaving water temperature, design and actual
10. Entering air temperature, design and actual
11. Leaving air temperature, design and actual
12. Air pressure drop, design and actual

I. Air Moving Equipment:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and actual
7. Return air flow, specified and actual
8. Outside air flow, specified and actual
9. Total static pressure (total external), specified and actual
10. Inlet pressure
11. Discharge pressure

12. Sheave Make/Size/Bore
13. Number of Belts/Make/Size
14. Fan RPM

J. Return Air/Outside Air:

1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature
9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature
12. Design outside/return air ratio
13. Actual outside/return air ratio

K. Exhaust Fans:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Air flow, specified and actual
6. Total static pressure (total external), specified and actual
7. Inlet pressure
8. Discharge pressure
9. Sheave Make/Size/Bore
10. Number of Belts/Make/Size
11. Fan RPM

L. Duct Traverses:

1. System zone/branch
2. Duct size
3. Area
4. Design velocity
5. Design air flow
6. Test velocity
7. Test air flow
8. Duct static pressure
9. Air temperature
10. Air correction factor

M. Duct Leak Tests:

1. Description of ductwork under test
2. Duct design operating pressure
3. Duct design test static pressure
4. Duct capacity, air flow
5. Maximum allowable leakage duct capacity times leak factor
6. Test apparatus
    a. Blower
    b. Orifice, tube size
    c. Orifice size
    d. Calibrated
7. Test static pressure
8. Test orifice differential pressure
9. Leakage

N. Terminal Unit Data:

1. Manufacturer
2. Type, constant, variable, single, dual duct
3. Identification/number
4. Location
5. Model number
6. Size
7. Minimum static pressure
8. Minimum design air flow
9. Maximum design air flow
10. Maximum actual air flow
11. Inlet static pressure

O. Air Distribution Tests:

1. Air terminal number
2. Room number/location
3. Terminal type
4. Terminal size
5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow

P. Sound Level Reports:

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

Q. Vibration Tests:

1. Location of points:
    a. Fan bearing, drive end
    b. Fan bearing, opposite end
    c. Motor bearing, center (if applicable)
    d. Motor bearing, drive end
    e. Motor bearing, opposite end
    f. Casing (bottom or top)
    g. Casing (side)
    h. Duct after flexible connection (discharge)
    i. Duct after flexible connection (suction)
2. Test readings:
    a. Horizontal, velocity and displacement
    b. Vertical, velocity and displacement
    c. Axial, velocity and displacement
3. Normally acceptable readings, velocity and acceleration
4. Unusual conditions at time of test
5. Vibration source (if non-complying)

END OF SECTION 230593

SECTION 230714 - HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Duct insulation.

B. Flexible Blanket Fireproofing.

C. Noise Barrier Wrap.

1.2 RELATED SECTIONS

A. Section 23 0554 - Identification for HVAC Piping and Equipment.

1.3 REFERENCES

A. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2002.

B. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2004.

C. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2005.

D. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.

E. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.

F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

G. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

I. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

C. Submit MSS information for all products.

1.5 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

C. All insulation and adhesives shall be formaldehyde free.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

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

2.2 GLASS FIBER, FLEXIBLE

A. MANUFACTURER:

1. Johns Manville Corporation: www.jm.com. Microlite XG.
   a. Approved formaldehyde-free equal.

B. Insulation: ASTM C 553-92; formaldehyde-free, flexible glass fiber, noncombustible blanket.

1. 'K' ('Ksi') value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C 518.
   a. Maximum Service Temperature: 450 degrees F (232 degrees C).
   b. Maximum Water Vapor Sorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:

1. Porous interior sealant primers shall not have VOC content in excess of 775 grams/liter, less water and compounds exempt by the applicable LEED standard.
2. Kraft paper with glass fiber yarn and bonded to aluminized film.
3. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
4. Secure with pressure sensitive tape.
5. Vapor Barrier Tape:
   a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive formaldehyde-free rubber based adhesive.

2.3 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Fiber Glass: www.knauffiberglass.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 612; rigid, noncombustible blanket.

1. 'K' ('Ksi') value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C 518.
2. Maximum service temperature: 450 degrees F (232 degrees C).
3. Maximum Water Vapor Sorption: 5.0 percent.
4. Maximum Density: 8.0 lb/cu ft (128 kg/cu m).

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
3. Secure with pressure sensitive tape.

2.4 FLEXIBLE BLANKET FIREPROOFING:

A. Manufacturers:

1. 3M
2. Approved Equal.
3. Material: high temperature soluble fiber blanket encapsulated in scrim reinforce aluminum foil covering.
4. Weight: 0.75 lb/sf
5. Systems: Ducts requiring 2 hour fire rating.
6. Combustibility (ASTM E-136): Noncombustible.
7. Two layers required.
8. Must conform with governing IMC requirements.

2.5 NOISE BARRIER WRAP (HUSH CLOTH)

A. Manufacturers:

1. Kinetics Noise Barrier Type KNM-100ALQ.
2. BRD
3. Approved Equal
4. Provide barium sulphate loaded limp vinyl sheet bonded to a a thin layer of reinforced aluminum foil on one side.

B. Provide nominal density of 1 PSF and minimum STC rating of 28.

C. Barrier shall have minimum thermal conductivity "K" value of 0.29 and rated temperature range of -40 degrees C to 105 degrees C.

D. Provide decoupling layer of 2" fiberglass batting, non-woven porous scrim coated glass clothy, quilted together in a matrix of 100 mm (4") diamond stitch patter encapsulating the glass fibers. Decoupler shall be model KFA by Kinetics or equal.

E. The composite material shall be fabricated to include a nominal 6" wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak tight seal around all field joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulated ducts conveying air below ambient temperature:

1. Provide insulation with vapor barrier jackets.
2. Finish with tape and vapor barrier jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
5. Insulated ducts conveying air above ambient temperature:
    a. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. External Duct Insulation Application:

1. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
2. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
3. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
4. Install Insulation materials with smooth and even surfaces.
5. Maintain integrity of vapor barrier on ductwork insulation, and protect it to prevent puncture and other damage.
6. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations except where otherwise indicated.

3.3 PROTECTION AND REPLACEMENT:

A. Replace damaged insulation, which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: The installer of the ductwork insulation shall advise the contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.4 SCHEDULES

A. All fresh air intake ducts from the outside intake louver or vent to the unit casing shall be insulated on the outside with 2" thick fiberglass.

B. All supply air ductwork of air conditioning systems shall be externally insulated except where ductwork is installed exposed in the conditioned space.

C. Return air ductwork of air conditioning systems shall be insulated wherever the ductwork runs under a roof. Insulation thickness shall be 1.5"

D. All exhaust and relief air ducts shall be externally insulated with 2.0" thick fiberglass from the backdraft device to the louver.

E. Dual Temperature Ductwork:

1. Application Requirements: Where leaving air temperature is alternately above and below ambient temperature insulate and vapor seal ductwork.
2. Externally Insulated Ductwork: Provide with one of the following types and thicknesses of insulation, except as otherwise indicated:
   a. Insulation: Rigid mineral fiber, 3 PCF in concealed areas, 6 PCF in exposed areas, supply and return ducts – 2.0” thick, outside air ducts – 2” thick.
   b. Insulation: Flexible mineral fiber, 2" thick, application limited to concealed locations. Density shall be 1.5 pounds/cubic foot.

F. Noise Barrier Duct Wrap

1. Provide Noise Barrier Wrap (Hush Cloth) where indicated on the drawings.

END OF SECTION 230714

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

1.2 RELATED SECTIONS

A. Section 23 0554 - Identification for HVAC Piping and Equipment.

B. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

C. Section 23 21 14 - Hydronic Specialties.

D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCES

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.

C. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2010.

D. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007.

E. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007.

F. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.

G. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2011.

H. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2012.

I. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2011.

J. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2010.

K. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.

L. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2010.

M. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

O. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturers:

1. Knauf Insulation: www.knaufusa.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 553; flexible, noncombustible.

1. 'K' Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Sorption: 5.0 percent by weight.

C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.

1. Moisture Vapor Permeability: 0.029 ng/Pa s m (0.02 perm inch), when tested in accordance with ASTM E 96/E 96M.
2. Secure with self-sealing longitudinal laps and butt strips.

2.3 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Insulation: www.knaufusa.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 612 or ASTM C592; rigid, noncombustible.

1. 'K' Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
2. Maximum Service Temperature: 850 degrees F.
3. Maximum Water Vapor Sorption: 5.0 percent by weight.
4. Maximum Density: 8.0 lb/cu ft.

C. Vapor Barrier Jacket:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.029 ng/Pa s m (0.02 perm inch), when tested in accordance with ASTM E 96/E 96M.
3. Secure with self-sealing longitudinal laps and butt strips.

2.4 JACKETS

A. PVC Plastic:

1. Manufacturers:

a. Johns Manville Corporation: www.jm.com.

2. Jacket: Sheet material, off-white color.
   a. Minimum Service Temperature: -40 degrees F.
   b. Maximum Service Temperature: 150 degrees F.
   c. Moisture Vapor Permeability: 0.029 ng/Pa s m (0.02 perm inch), when tested in accordance with ASTM E 96/E 96M.
   d. Thickness: 10 mil.
   e. Connections: Brush on welding adhesive.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.

1. Thickness: 0.016 inch sheet.
2. Finish: corrugated.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

C. Exposed Equipment: Locate insulation and cover seams in least visible locations.

D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated equipment containing fluids below ambient temperature: Insulate entire system.

G. Fiber glass insulated equipment containing fluids below ambient temperature: Provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

J. Fiber glass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

K. Inserts and Shields:

1. Application: Equipment 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between hangers and inserts.
3. Insert location: Between support shield and equipment and under the finish jacket.
4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

L. Finish insulation at supports, protrusions, and interruptions.

M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

N. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

O. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

P. Replace damaged insulation which cannot be repaired satisfactorily including units with vapor barrier damage and moisture saturated units.

Q. Protection: Insulation Installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.3 SCHEDULE

A. Heating Systems:
1. Pump Bodies: 2" thick rigid fiberglass with cement finish
    1) Provide removable sheet metal insulation boxes with cam locks for pumps.
2. Air Separators: 2" thick flexible unicellular.
3. Expansion Tanks: 2" thick flexible unicellular.

B. Chilled Water Systems:
1. Pump Bodies: 1.5” thick flexible unicellular.
    1) Provide removable sheet metal insulation boxes with cam locks for pumps.
2. Air Separators: 1.5” thick flexible unicellular.
3. Expansion Tanks: 1.5” thick flexible unicellular.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 RELATED SECTIONS

A. Section 07 8413 – Penetration Firestopping.

B. Section 07 8443 – Joint Firestopping.

C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCES

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.

C. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2010.

D. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007.

E. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2000.

F. ASTM C 533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2011.

G. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2007a.

H. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation; 2012.

I. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2012.

J. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2011be1.

K. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 2010.

L. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2012a.

M. ASTM C 610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation; 2011.

N. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008.

O. ASTM D 1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2007.

P. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2006.

Q. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.

R. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2010.

S. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

T. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

U. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

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

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

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

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.2 GLASS FIBER

A. Manufacturers:

1. Knauf Insulation: www.knaufusa.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 547 and ASTM C795; rigid molded, noncombustible.

1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum service temperature: 850 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.

C. Insulation: ASTM C 547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.

1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum service temperature: 650 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

1. Armacell LLC

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3; use molded tubular material wherever possible.
1. Minimum Service Temperature: -40 degrees F.
2. Maximum Service Temperature: 220 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

2.4 JACKETS

A. PVC Plastic.

1. Manufacturers:
   a. Johns Manville Corporation: www.jm.com.
   b. Owens Corning Corp..
   c. Knauf Insulation.
2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
   a. Minimum Service Temperature: 0 degrees F.
   b. Maximum Service Temperature: 150 degrees F.
   c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
   d. Thickness: 10 mil.
   e. Connections: Brush on welding adhesive.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.

1. Thickness: 0.016 inch sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations. Exposed piping in visible areas shall be wrapped in an aluminum jacket with a paint-grip finish.

C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

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

E. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

F. Inserts and Shields:

1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

H. Exterior Applications: Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

I. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum or PVC jacket as noted in the schedule with seams located on bottom side of horizontal piping. Provide warning tape on exterior of pipe indicating that the piping is heat traced.

J. General: Install insulation products in accordance with the manufacturer's written instructions, and in accordance with the recognized industry practices to ensure that the installation serves its intended purpose.

K. Install insulation of pipe systems subsequent to testing and acceptance of tests.

L. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete the run. Do not cut pieces of scraps abutting each other.

M. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

N. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at installer's option) except where a specific form or type is indicated. Valves in chilled water systems shall be insulated with removable factory pre-molded insulators. Any condensation problems shall be corrected by the Contractor. Damage to finishes caused by condensation shall be corrected by this Contractor.

O. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

P. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.

Q. Pipe Hanger Insulation Inserts: Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 inch wide vapor barrier stage or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inch wide vapor barrier tape or band.

R. Replace damaged insulation which cannot be repaired satisfactorily including units with vapor barrier damage and moisture saturated units.

S. Protection: Insulation Installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.3 SCHEDULE

A. HVAC Systems:

1. HVAC PIPING SYSTEM INSULATION:
   a. Sub-Freezing Piping (0 to 39 Deg. F.) (-18 to 4 Deg. C.):
      1) Application Requirements: Insulate the following sub-freezing HVAC piping systems:
         (a) Refrigerant suction and liquid lines between evaporators and condensing units.
         (b) Refrigerant suction and liquid lines between split-compressor chillers and condensing units.
      2) Insulate each piping system specified above with one of the following types and thickness of insulation:
         (a) Insulation: Flexible unicellular 1.5” thick. Cover outdoor insulation with aluminum jacket.
   b. Cold Piping (40 Deg. F. (4.4 Deg. C. to ambient):
      1) Application Requirements: Insulate the following cold HVAC piping systems:
         (a) Copper air conditioning condensate piping. (Insulation not required on PVC condensate piping).
         (b) Chilled water piping systems.
      2) Insulate each piping system specified above with one of the following types and thicknesses of insulation:
         (a) Insulation: Flexible Unicellular; 1.5" thick on chilled water. 1/2" thick on condensate drains.
         (b) Outdoor Application: Increase insulation thickness by 1 inch. Where pipes are heat traced, increase size to accommodate the heat tracing. Cover with 22 gauge corrugated aluminum with all joints sealed watertight.
   c. Hot Low Pressure Piping (to 250 Deg. F. (121 Deg. C.):
      1) Application Requirements: Insulate the following hot low pressure HVAC piping systems.
         (a) HVAC hot water supply and return piping.
      2) Insulate each piping system specified above with one of the following types and thickness of insulation:

(a) Insulation: Fiberglass; 1 1/2" thick for pipe sizes up to and including 1.5". 2" thick for pipe sizes 2" and larger.

(b) Insulation: Flexible unicellular 1.5" thick for pipe sizes up to and including 1.5".

3) Cover outdoor insulation with 22 gauge corrugated aluminum.

d. Outdoor Pipes:

1) Outdoor HVAC water pipes, including piping located in air handling unit pipe portals, shall be heat traced and insulated with 2 inch insulation, and covered with an aluminum jacket. Refer to paragraphs 3.2.H and I.

END OF SECTION 230719

SECTION 230923 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements, (if any), apply to the work specified in this section.

1.2 DESCRIPTION OF WORK:

A. The extent of the electric/electronic Direct Digital Control temperature control work is indicated by drawings and schedules and by the requirements of this section.

B. Control sequence is hereby defined to mean the manner in which, and methods by which, the automatic temperature controls function. The requirements for each type of operation are specified in this section.

C. The control system shall be Schneider Electric EcoStruxure by the Tri-M Group. Contact Matt Prisuta (MPrisuta@tri-mgroup.com) (484)790-5760. Substitutions will not be permitted.

1.3 GENERAL:

A. The temperature control manufacturer shall furnish all material, equipment and services necessary for the proper installation of an electric/electronic system of automatic temperature controls. Temperature control equipment shall submit to the Engineer for approval shop drawings of the entire control system prior to commencement of work.

B. After completion of the installation, the automatic temperature control contractor shall adjust all thermostats, control dampers, motors and other equipment provided under his contract with trained personnel in the direct employ of the temperature control manufacturer. The control system as shown on the Drawings and specified herein shall be guaranteed free from defects in workmanship and materials under normal use and service for a period of one year, after acceptance by the Engineer and/or Owner.

C. Any equipment herein described proved to be defective in workmanship or material during the guarantee period shall be adjusted, repaired or replaced by the automatic temperature control manufacturer at no charge to the Owner. Instructions shall be given to Owner's personnel.

1.4 SCOPE OF WORK:

A. The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems as herein specified. Complete temperature control system as specified herein. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer

has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.

B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

C. BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.

D. BAS manufacturer shall provide a lifetime license for the software for this facility. License shall include future software upgrades.

E. BAS manufacturer shall be responsible for installation of their system on District-provided servers and on two District-owned laptop computers.

1.5 COORDINATION OF WORK:

A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc. furnished by BAS manufacturer.

B. Electrical Contractor provides:

1. 120 volt power wiring and data where shown on the drawings. Any and all other 120V power as required for all controls operations and devices shall be provided by the BAS manufacturer as part of the heating contract.
2. Wiring of all power feeds through all disconnect starters to electrical motor.
3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer.

C. Products furnished but not installed under this section:

1. Section 23 2113 Hydronic Piping:
   a. Control Valves
   b. Flow Switches
   c. Temperature Sensor Wells and Sockets
   d. Flow Meters
2. Section 23 3100 - Duct-work Accessories:
   a. Automatic Dampers
   b. Air-flow Stations
   c. Terminal Unit Controls

1.6 QUALITY ASSURANCE

A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 75 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.

B. The manufacturer shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS.

C. The Bidder shall be regularly engaged in the manufacturing, installation, and maintenance of the specified BAS systems, and shall have a minimum of ten (15) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project. The Bidder must also have and maintain a service organization consisting of at least ten (10) competent servicemen for a period of not less than ten years and the provide a list of 10 projects, similar in size and scope to this project completed within the last five years.

D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

E. BAS shall comply with UL 916 PAZX and 864 UDTZ, ULC, and other subsystem listings as applicable, and herein specified, and be so listed at the time of bid.

F. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

G. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

H. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.7 CODE COMPLIANCE

A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

C. All wiring shall conform to the National Electrical Code.

D. All smoke dampers shall be rated in accordance with UL 555S.

E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

F. Comply with FCC, Part 68 rules for telephone modems and data sets.

G. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

H. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.

I. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.8 SUBMITTALS

A. Provide submittals for fast track items that need to be approved and released to meet the schedule of the project. Provide submittals for the following items separately upon request:

1. Valve schedule and product data
2. Damper schedule and product data
3. Mounting and wiring diagrams for factory-installed control components

B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:

1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
2. Wiring Diagrams: Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.
3. Details of control panel faces, including sizes, controls, instruments, and labeling.
4. Schedule of dampers and actuators including size, leakage, and flow characteristics. If dampers are furnished by other, submit a schedule coordinating actuator sizes with the damper schedule.
5. Schedule of valves including leakage and flow characteristics.
6. Written description of the Sequence of Operations.
7. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
8. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

9. Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.

C. Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

D. Variance letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.

1.9 WARRANTY

A. Conform to the warranty requirement of the Contract Documents, General Requirements and this section or a minimum of 12 months. This warranty shall apply equally to both hardware and software.

B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system demonstration.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.

D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner’s Representative.

1.10 COORDINATION

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

B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

D. Coordinate location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete".

E. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

1.11 SYSTEM DESCRIPTION

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer

controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

B. For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): The BAS Contractor shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
3. Ethernet-based Network Router and/or Network Server Controller(s) (NSCs): The BAS Contractor shall furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units (SDCUs) and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).

C. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, XML and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

D. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

E. The system shall enable an open architecture that utilizes ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

F. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

G. The software tools required for network management of the BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP.

H. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.

I. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.

1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
2. Data shall reside on a supplier-installed server for all database access.
3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.

J. Provide the Commissioning, configuration and diagnostic software, and interfaces to provide uploading/downloading and monitoring of all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of time schedules.

PART 2 - PRODUCTS

2.1 SYSTEM ARCHITECTURE

A. General

1. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire project, and interface with the Local Area Network (LAN) or Wide Area Network (WAN) as required.
2. The Building Automation System (BAS) shall consist of:
   a. Network Server/Controllers (NSCs),
   b. Standalone Digital Control Units (SDCUs)
   c. Administration and Programming Workstations (APWs)
   d. Enterprise Server (ES) (optional, used on large jobs)
   e. Report Server (RS) (optional, used on jobs for extended logging/reporting capabilities)
   f. Web-based Operator Workstations (WOWs)..
3. Where two or more NSCs are included, an Enterprise Server is required, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from Workstations simultaneously for operations and engineering tasks.
4. The Enterprise Level BAS shall be able to host up to 250 Network Servers (NSCs) beneath it.
5. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows SQL based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
6. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, and/or Modbus TCP protocol.

B. Modbus RTU, Modbus TCP, BACnet MS/TP, BACnet IP, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow these protocols to be natively supported.

C. A Fieldbus network of Standalone Digital Control Units (SDCUs) using the BACnet IP, BACnet MS/TP protocol shall connect the SDCUs with an Ethernet-level NSC using managed Ethernet switches where required. The NSC shall have a fixed IP address for connection the facility network and the SDCUs shall have separate, non-facility BACnet addresses assigned and managed by the NSC.

D. BACnet IP Fieldbus SDCUs shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 39 if using RSTP, per layer, with a max of 5 sub networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs.

E. BACnet MS/TP Fieldbus SDCUs shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.

F. BAS LAN Segmentation: The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

G. Standard Network Support: All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

H. Web Services : The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable. The NSC shall be able to "consume" data into the system via SOAP and REST web services

I. System Expansion

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. Web-based operation shall be supported directly by the NSCs and require no additional software.
3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
4. All Network Server Controllers must natively support the open systems protocols of: BACnet IP, BACnet MS/TP, Modbus TCP and Modbus RTU protocols.

2.2 OPERATOR WORKSTATION REQUIREMENTS

A. General

1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 2 concurrent operator users and/or 1 concurrent engineering user.
2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.

3. Web-based workstations (webstations) shall have a minimum of 5 concurrent operator users.
4. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
5. A minimum of 2 physical Workstations shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC.

B. Workstation, Programming Workstation, and Enterprise Server Requirements (specifier to depict owner provided server or controls contractor provided server):

1. Processor Intel Core i5 @ 3.0 GHz or better
2. Memory: Minimum: 8GB RAM, 300 GB or larger hard disk, DVD drive
3. Operating systems:
   a. Microsoft Windows 10 64-bit (Pro or Enterprise)
   b. Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
   c. Microsoft Windows Server 2012 or 2102 R2 or 2016 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
4. 10/100MBPS Ethernet NIC
5. SQL (Report Server only) Software - Microsoft SQL Server 2008 R2 with SP2 or 2012 64-bit (Standard and Express with Advanced Services)
6. License agreement for all applicable software

C. Web-Based Operator PC Requirements - Any user on the network can access the system, using Internet Explorer 11, or Mozilla Firefox, or Google Chrome

D. System Software Architecture

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. Programming of controllers shall be capable of being done either off-line or on-line from any programming workstation. All information will be available in graphic displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable

4. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.
   a. Additional requirements include mandatory change of passwords:
      1) At first logon with default credentials
      2) Of admin passwords before deploying
   b. No general accounts, one account per user
   c. Capability to integrate and use Windows Active Directory for user log on credentials
   d. Include a timed auto log off feature
   e. Use TLS 1.2 encryption or higher
   f. Capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
   g. All devices and software that support HTTP shall allow disabling the HTTP access and require access via HTTPS.
   h. All devices that have web portals for the configuration of IP addresses and other configuration attributes shall have the ability, through commands issued, to disable this service upon completion. A direct connection method with ASCII commands shall enable this service again if changes need to be applied. Loss of power or cycling the device shall not reverse this command. Disabling this web portal eliminates the security risk and the need for updating security patches.
   i. All devices shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
   j. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
   k. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.

E. Web-based Operator Software

1. General:
   a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
   b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.

2. Graphic Displays
    a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
    b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
3. Alarm Management
    a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
    b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.
4. Groups and Schedules
    a. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
    b. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.
5. User Accounts and Audit Trail
    a. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
    b. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

F. User Workstation:
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
2. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.

3. Personalized layouts and panels based on username and passwords within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
4. Workstations, Servers and NSCs shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
5. Workstation shall indicate at all times the communication status between it and the server.

G. Administration and Programming Workstation

1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all "child" objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays

1. The Administration and Programming Workstation shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
   a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
   b. The system shall support HTML5 enabled graphics.
   c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
   d. The editor shall use Scalable Vector Graphics (SVG) technology.
   e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic

displays in a manner that mimics their mechanical equivalents found on field installed control panels.

f. Support for high definition icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
k. Graphics should rescale based on whatever monitor or viewing device is being used.
l. Be able to create graphics on varying layers that can be moved and repeated.
m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
n. The ability to create re-usable cascading menus.
o. The ability to have multiple instances of a graphic and edit one instance to change all.

3. Additionally, the Graphics Editor portion of the Engineering Workstation Software shall provide the following capabilities:
   a. Create, Modify and save pages.
   b. Modify an existing symbol and Group and Ungroup symbols.
   c. Place a symbol on a page and Rotate and Mirror a symbol.
   d. Place analog dynamic data and changeable setpoints on a page.
   e. Place binary dynamic data using custom state descriptors on a page.
   f. Create motion through the use of animated .gif files or JavaScript.
   g. Place links to other pages, websites, notes, time schedules and various files like .pdf, .doc, .exe etc. on the Workstation using a fixed symbol or flyover on a page.
   h. Place alarm indicators on a page.
   i. Change symbol/text/value color as a function of an analog or binary variable.
   j. All symbols used in the creation of graphic pages shall be saved to a library file for use by the owner.

I. Automatic monitoring

1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management

1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
   a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels. At the Enterprise level the minimum number of active and viewable alarms shall be 10,000. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
   b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
   c. Playing an audible sound on alarm initiation or return to normal.
   d. Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software using Simple Mail Transfer Protocol (SMTP) with support for secure email using Simple Mail Transfer Protocol Secure (SMTPS) No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
   e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-4pm, Mon-Fri) and to a Central Alarming workstation at all other times.
   f. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
   g. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
   h. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
   i. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
   j. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to ‘normal’ and the quantity of disabled and hidden alarms.
   k. The alarm viewer can be configured to auto hide alarms when triggered.
   l. An operator shall have the capability to assign an alarm to another user of the system.
   m. Time schedules shall be able to be used to set control notifications to users.
   n. An operator shall have the capability to save and apply alarm favorites.
   o. Alarm notifications must support multiple distribution methods within one notification.

K. Report Generation (optional)

1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.
4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
6. All reports shall be able to be set up to automatically run or be generated on demand.
7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
8. Reports can be of any length and contain any point attributes from any controller on the network.
9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
10. It shall be possible to run other executable programs whenever a report is initiated.
11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
12. Minimum supplied reports shall include:
    a. Activities Per Server Report
    b. Activities Per User Report
    c. Alarm Amount by Category Report
    d. Alarm Amount by Type Report
    e. Alarms Per Sever Report
    f. Current Alarm Report
    g. Most Active Alarm Report
    h. System Errors Per Server Report
    i. Top Activities Report
    j. Top Alarms Report
    k. Top System Errors Report
    l. Trend Log Comparison Report
    m. User Logins Report
    n. Users and Groups Reports
13. Minimum Energy Reports shall include:
    a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
    b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.

c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

L. Scheduling

1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
10. It should accommodate a minimum of 16 priority levels.
11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer's Environment

1. Programming shall allow both graphical block format and line-programming format. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs. Both languages will have debugging capabilities in their editors.
2. Programming of the NSC and SDCUs shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
4. It shall be possible to view graphical programming live and real-time from the Workstation.
5. The system shall be capable of creating ‘binding templates’ allowing the user to bind multiple points to multiple objects all at once.
6. Key terms should automatically complete when typing (IntelliType).

7. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different functions.
8. The system shall be able to create macro objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.
9. The workstation software shall have an application to save and restore programming and graphic files. The application must also be able to save/reload individual programs in the controller allowing modification of control programs without disturbing any other online functions.

N. Audit Trail

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. The Enterprise server shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. It shall be capable to search and view all forced values within the system.

2.3 NETWORK SERVER CONTROLLERS (NSCS)

A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The NSC shall be classified as a “native” BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The NSC shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

E. Whitelisting of file extensions for documents shall be capable.

F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2

G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU, chiller system or boiler system.

J. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

K. Each NSC shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization by means of an Internet site including automatic synchronization
6. Native integration of Modbus controller data or BACnet controller data

L. Hardware Specifications

1. Memory:
   a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Each NSC shall provide the following on-board hardware for communication:
   a. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
      1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
      2) Support IPv4 addressing
      3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
      4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
      5) It shall be possible to disable Ethernet port 2

6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
7) Each NSC shall be able to support a total of 250 IP SDCUs in daisy chain configuration (5 sub networks via switch)
8) If using RSTP (Rapid Spanning Tree Protocol) with a managed switch (with IEEE 802.1W or IEEE 802.1Q-2014 support), Ethernet port 2 shall support up to 39 devices
9) Each NSC shall be able to support a total of 234 IP SDCUs in RSTP configuration (6 sub networks via managed switch)
10) Where a switch is needed, use Planet IGS-801M, or other equal and approved equivalent.
    a) Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
    b) One device USB port
    c) One host USB port

M. Modular Expandability:

1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic.
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

N. Hardware Override Switches:

1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

O. Universal Input Temperatures

1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.

a. 10 kohm Type I, II, III, IV or V
b. 1.8 kohm (Xenta), 1 kOhm (Balco), 20 kOhm (Honeywell) and 2.2 kOhm (JCI)

P. Local Status Indicator Lamps:

1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

Q. Real Time Clock (RTC):

1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
2. The RTC date and time shall also be accurate, up to 30 days, when the NSC is powerless.
3. No batteries may be used to for the backup of the RTC.

R. Power Supply:

1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and any associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

S. Automatic Restart After Power Failure:

1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.
2. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

T. Software Specifications

1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control

function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

U. User Programming Language:

1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a "canned" program method will not be accepted.

V. Control Software:

1. The NSC shall have the ability to perform the following pre-tested control algorithms:
   a. Proportional, Integral plus Derivative Control (PID)
   b. Two Position Control
   c. Digital Filter
   d. Ratio Calculator
   e. Equipment Cycling Protection

W. Mathematical Functions:

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

X. NSCs shall have the ability to perform any or all of the following energy management routines:

1. Time of Day and Calendar Scheduling with Holiday and Temporary Overrides
2. Optimal Start & Optimal Stop with Night Setback Control
3. Enthalpy Switchover (Economizer)
4. Peak Demand Limiting
5. Temperature Compensated Duty Cycling
6. Supply Fan demand based pressure reset
7. Heating/Cooling Interlock with Hot/Cold Deck Reset
8. Hot Water, Chilled Water and Condenser Reset

9. Chiller Sequencing and Chiller Plant Optimization

Y. History Logging:

1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.

Z. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an

alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.

6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

AA. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

2.4 BACNET IP FIELDBUS CONTROLLERS (SDCUS)

A. Controllers – BACnet/IP Protocol

1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
   a. All controllers shall be able to communicate peer-to-peer without the need for a NSC
   b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

1. Supporting IPv4 addressing
2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
3. It shall be possible to disable Ethernet port 2

C. Topologies

1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
   a. In case of any disruption there shall be no communication interruption
   b. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability

1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
   a. Control processes
   b. Energy management applications
   c. Alarm management
   d. Historical/trend data
   e. Maintenance support applications

f. Custom processes
g. Manal override monitoring

9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
    a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
        1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
            a) 10 kohm Type I, II, III, IV or V
            b) 1.8 kohm (Xenta), 1 kOhm (Balco), 20 kOhm (Honeywell) and 2.2 kOhm (JCI)
        2) Analog inputs
            a) Current Input - 0-20 mA
            b) Voltage Input 0-10 Vdc
        3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
        4) Digital outputs
        5) Analog outputs of 4-20 mA and/or 0-10 Vdc
13. Real Time Clock (RTC):
    a. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month. The RTC shall provide the following: time of day, day, month, year, and day of week.
    b. The RTC date and time shall also be accurate, up to 7 days, when the BACnet/IP Fieldbus controller is powerless.
    c. No batteries may be used to for the backup of the RTC.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
    a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in ‘flow thru’ differential pressure transducer
    b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of ±5% at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters
    c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
    d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
    e. All balancing parameters shall be synchronized in NSC
15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
16. Power Requirements.: 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power

F. Commissioning Tool - The BACnet/IP Fieldbus controller shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout

1. The Commissioning Tool shall be supported across: iOS, Android and Windows 10 platforms
2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store
3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via a Bluetooth adapter interface through the Intelligent Space Sensor or via a Wi-Fi access point on the LAN
4. Functionality
   a. Device Configuration – the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller
   b. Programming – The Commissioning Tool shall be able to load offline engineered applications directly in to the controller directly
   c. Air Balancing
      1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
      2) The Commissioning Tool shall be able to generate Air Balancing report
   d. IO Checkout
      1) The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live
      2) The Commissioning Tool shall be able to support generation of I/O checkout report
   e. There shall be no limit to the number of Commissioning Tools that can be used on a network segment, however, one connection per controller is recommended

G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on board inputs or outputs

1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable
2. The Intelligent Space Sensor shall provide 2 RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream
3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O
4. Each Intelligent Space Sensor shall provide a color touch display with a Minimum 61 mm (2.4”) by 61 mm (2.4”) display that is backlit
5. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ±0.2 °C (±0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C. Sensing Element: 10k Type 3 Thermistor, Accuracy of ±0.2 °C (±0.4 °F)

6. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH, Accuracy: ±2 % RH

H. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution

1. Accuracy: ±30 ppm ±2% of measured value
2. Operating elevation: 0 to 16,000 ft.
3. Temperature dependence: 0.11% FS per ˚F
4. Stability: <2% of FS over life of sensor (15 years)
5. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling

I. The Intelligent Space Sensor shall have the option for motion sensor

J. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:

1. Space temperature
2. Cooling space temperature set point
3. Heating space temperature set point
4. Current heating or cooling mode
5. Current occupancy mode
6. Fan speed
7. Current time

2.5 BACNET MSTP FIELDBUS CONTROLLERS (SDCUS)

A. Field Bus Wiring and Termination

1. The wiring of MSTP controller shall use a bus or daisy chain concept with no tees, stubs.
2. Each field bus shall have a termination resistor at both ends of each segment.

B. Field Bus Devices

1. General Requirements

a. Devices shall have a light indicating that they are powered.
b. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

C. Advance Application Controllers (B-AAC)

1. The key characteristics of a B-AAC are:
   a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
   b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
   c. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
   d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
   e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
   f. If local alarm message initiation is embedded, the B-AAC shall:
      1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
      2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
   g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
   h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
   i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
   j. Shall support the "Who is" and "I am." BACnet services.
   k. Shall support the "Who has" and "I have." BACnet services.
2. Analog Input Circuits
   a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
   d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

3. Binary Input Circuits
    a. Dry contact sensors shall wire to the controller with two wires.
    b. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
    a. Pulse input sensors shall wire to the controller with two wires.
    b. An external power supply in the sensor circuit shall not be required.
    c. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
    a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
    b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
6. Binary Output Circuits
    a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
    b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
7. Program Execution
    a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
    b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
    c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
    d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
    e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

PART 3 - AUXILIARY CONTROL DEVICES

3.1 GENERAL DEVICE REQUIREMENTS

A. The use or installation of wireless equipment must be pre-approved by the owner and engineer. (Specifier to determine whether wireless devices are acceptable)

3.2 CONTROL VALVES

A. Control valves shall be two-way or three-way type for two position or modulating service as shown.

B. Close-off (Differential) Pressure Rating: Water Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

1. Two Way: Close-off (Differential) Pressure Rating of actuator and trim shall be furnished to 150 percent of total system (pump) head.
2. Three Way: Close-off (Differential) Pressure Rating of actuator and trim shall be furnished to 300 percent of pressure differential between ports A and B at design flow or 100 percent of total system (pump) head.

C. Water Valves

1. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
2. Sizing Criteria
   a. Two Position Service: Line size with Close-off (Differential) Pressure Rating of actuator and trim of a minimum of 150 percent of total system (pump) head.
   b. Two Way Modulating Service: Pressure drop shall be equal to 50 percent of the pressure difference between supply and return mains, or 5 PSI, whichever is greater.
   c. Three Way Modulating Service: Pressure drop equal to twice the pressure drop through the coil, 5 PSI maximum.
   d. Valves 1/2 inch through two inches shall be bronze body or cast brass ANSI Class 250, spring loaded, PTFE packing, quick opening for two position service. Two-way valves to have replaceable composition disc or stainless steel ball.
   e. Valves 2-1/2 inches and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
3. Water valves shall fail (normally open or closed), as scheduled on plans, or as follows:
   a. Water Zone Valves: Normally open preferred.
   b. Heating Coils in Air Handlers: Normally open.
   c. Chilled Water Control Valves: Normally closed.
   d. Terminal Water Control Valves: Last position unless indicated otherwise.
   e. Other Applications: As scheduled or as required by sequences of operation.

D. Approved manufacturer: Belimo, Schneider Electric

3.3 CONTROL DAMPERS

A. Unless otherwise specified elsewhere, shall be as below or as scheduled on drawings.

1. Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct airstreams toward each other.
2. Other modulating dampers shall be the opposed blade type.
3. Two position shutoff dampers may be parallel or opposed blade type with blade and side seals.

B. Damper frames shall be 13 gauge galvanized steel channel or 1/8 inch extruded aluminum with reinforced corner bracing.

C. Damper blades shall not exceed 20 centimeters (eight inches) in width or 125 centimeters (48 inches) in length. Blades are to be suitable for medium velocity performance (2000 FPM). Blades shall be not less than 16 gauge.

D. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze or better.

E. All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at four inches w.g. differential pressure. Provide air foil blades suitable for a wide-open face velocity of 1500 FPM.

F. Individual damper sections shall not be larger than 48 inches by 60 inches. Provide a minimum of one damper actuator per section.

G. Modulating dampers shall provide a linear flow characteristic where possible.

H. Dampers shall have exposed linkages.

I. Approved manufacturer: Arrow or approved equal.

3.4 ELECTRIC ACTUATORS FOR CONTROL DAMPERS OR CONTROL VALVES

A. The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.

B. Where shown, for power failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided.

C. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.

D. All 24 VAC/VDC actuators shall operate on Class 2 wiring.

E. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 7 N.m (60 inches-pound) torque capacity shall have a manual crank for this purpose.

F. Approved manufacturer: Belimo, Schneider Electric

3.5 TEMPERATURE SENSORS

A. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.

B. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of five feet in length per ten square feet of duct cross section.

C. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.

D. Space sensors shall be equipped with setpoint adjustment, override switch, display, and/or communication port as shown.

E. Provide matched temperature sensors for differential temperature measurement.

F. Low Limit Thermostats: Low limit air stream thermostats shall be UL listed, vapor pressure type, with an element of 20 feet minimum length. Element shall respond to the lowest temperature sensed by any one foot section. The low limit thermostat shall be manual reset only.

G. Approved manufacturer: Schneider Electric

3.6 HUMIDITY SENSORS

A. Duct and room sensors shall have a sensing range of 20 percent to 80 percent.

B. Duct sensors shall be provided with a sampling chamber.

C. Outdoor air humidity sensors shall have a sensing range of 20 percent to 95 percent relative humidity. They shall be suitable for ambient conditions of -40 degrees F to 170 degrees F.

D. Humidity sensor's drift shall not exceed one percent of full scale per year.

E. Approved manufacturer: Schneider Electric, Veris

3.7 RELAYS

A. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

3.8 LOCAL CONTROL ENCLOSURES

A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key lock latch and removable sub panels. A single key shall be common to all field panels and sub panels.

B. Interconnections between internal and face mounted devices shall be pre-wired with color coded stranded conductors neatly installed in plastic troughs and/or tie wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

C. Provide on/off circuit breaker with proper over current rating for control power sources to each local panel.

D. All outside mounted enclosures shall meet the NEMA-4 rating.

PART 4 - EXECUTION

4.1 CONTRACTOR RESPONSIBILITIES

A. General : Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

B. Demolition : Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor. The BAS sub-contractor will be responsible for maintaining any existing equipment throughout the phasing of the project and ensuring that existing control devices are functional until the time that they are removed.

C. Code Compliance : All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.

D. Cleanup : At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

4.2 WIRING, CONDUIT, AND CABLE

A. All wire will be copper and meet the minimum wire size and insulation class listed below:

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

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

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

D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 3/4 inch. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fittings, and galvanized rigid conduit where exterior conduits enter the building or between areas of high temperature/moisture differential.

E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings.

1. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.

H. Fiber optic cable shall only be installed and terminated by an experienced network technicians. The BAS contractor shall submit to the Engineer verification of fiber termination testing.

4.3 HARDWARE INSTALLATION PRACTICES FOR WIRING

A. The 120VAC power wiring provided by the electrical shall be a dedicated run to each control panel, with a separate breaker. A true earth ground must be available in the building. Corroded pipes, galvanized pipe, and structural steel must be certified to provide true earth grounding.

B. Control cables are to be attached to the building at regular intervals such that the cables do not droop. Wires are not to be affixed to or supported only by pipes, conduit, etc.

C. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.

D. Conduit, in non-finished areas will run parallel to or at right angles to the building structure.

E. Cables are to be kept a minimum of three (3) inches from hot water, steam, refrigerant or condensate piping.

F. Where sensor wires leave the conduit system, the edges of the conduit are to be protected by a plastic insert.

G. Provide fire caulking at all rated penetrations.

4.4 INSTALLATION PRACTICES FOR FIELD DEVICES

A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

E. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.

F. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

4.5 IDENTIFICATION

A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

B. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.

C. Junction box covers will be marked to indicate that they are a part of the BAS system.

D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.

E. All I/O field devices inside FIP's shall be labeled.

4.6 EXISTING CONTROLS.

A. Existing controls shall not be reused as party of the new systems. Existing controls which are to be found to be defective requiring construction will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair. The BAS sub-contractor will be responsible for maintaining any existing equipment throughout the phasing of the project and ensuring that existing control devices are functional until the time that they are removed.

4.7 CONTROL SYSTEM SWITCH-OVER

A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.

B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.

C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

D. The BAS sub-contractor will be responsible for maintaining any existing equipment throughout the phasing of the project and ensuring that existing control devices are functional until the time that they are removed.

4.8 SENSOR AND DEVICE LOCATION

A. The location of sensors and field devices is per mechanical and architectural drawings.

B. Space humidity or temperature sensors will be mounted away from machinery generating heat, from direct sunlight and from diffuser air streams.

C. Outdoor air sensors will be mounted on the outside of the north building. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

4.9 COLOR GRAPHIC DISPLAYS.

A. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

4.10 REPORTS.

A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:
1. Trend comparison data (optional)
2. Alarm status and prevalence information (optional)
3. Energy Consumption data (optional)
4. System user data (optional)

4.11 QUALITY ASSURANCE - SYSTEM STARTUP AND COMMISSIONING

A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

B. The BAS contractor shall commission and set in the automatic operating condition as specified by the sequence of operations all major equipment and systems, such as the chilled water, hot water and all air handling systems, after the equipment has been manually started and tested and in the presence of the equipment manufacturer’s representatives and the Owner and Architect’s representatives as applicable.

C. The BAS Contractor shall provide a technician for 2 days manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing hydronic and/or air systems in the building. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

D. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

E. Required elements of the startup testing include:

1. Measurement of voltage sources, primary and secondary
2. Verification of proper controller power wiring.

3. Verification of component inventory when compared to the submittals.
4. Verification of labeling on components and wiring.
5. Verification of connection integrity and quality (no loose strands and good tight connections).
6. Verification of bus topology, grounding of shields and installation of termination devices.
7. Verification of point checkout.
8. Each I/O device is landed per the submittals and has been verified to function as per the sequence of control.
9. Analog sensors are properly scaled and a field verified value is correctly reported
10. Binary sensors have the correct normal position and the state is correctly reported.
11. Analog outputs have the correct normal position and move full stroke when so commanded.
12. PID Loop control accuracy and stability of all analog control loops verified.
13. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
14. Written documentation of startup (measured value, reported value, date measured and tech name).

F. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.

1. System access and Graphics navigation and setpoint adjustment
2. Trend data collection and presentation.
3. Alarm handling, acknowledgement and routing.
4. Time schedule editing.
5. Report and Trend Log viewing.
6. Automatic backups and safe storage procedures
7. Web-based Operator Workstations access.

G. A final, written Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion and included in the Operations and Maintenance Manual.

4.12 OPERATION AND MAINTENANCE DOCUMENTATION (O&M)

A. The O&M shall include checkout sheets where each I/O device (both field mounted as well as those located in control panels) shall be inspected and verified for proper installation and functionality. The checkout sheets shall itemize each device and shall be filled out, dated and approved by the checkout technician for inclusion in the O&M.

B. The O&M shall include field checkout documentation of all controllers and front end equipment (Workstations, servers, printers, Ethernet switches, etc.) and shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be included in the O&M.

C. The O&M shall include an As-programmed sequence of operations, the Sequence of Operations Commissioning and System Startup Report and an electronic copy of all databases, configuration files, and system balancing and acceptance reports by others.

4.13 TRAINING

A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories. Training shall be provided on-site.

B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give two 8-hour days of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:

1. Explanation of drawings and operator’s maintenance manuals.
2. Walk-through of the job to locate all control components.
3. DDC Controller operation/sequence.
4. Operator control functions including scheduling, alarming, and trending.
5. Explanation of adjustment, calibration and replacement procedures.

END OF SECTION 230923

SECTION 230993 - HVAC CONTROL SEQUENCE

PART 1 - GENERAL:

1.1 DESCRIPTION OF THE WORK:

A. Control Sequence is hereby defined to mean the manner in which, and methods by which, the automatic temperature controls function. The requirements for each type of operation are specified in this section.

B. The operation equipment, devices and system components required for the automatic temperature control system are specified in Section 230923 of these specifications.

1.2 SUBMITTALS:

A. Refer to Submittal Section in Section 230923 for additional information.

B. General: Submittals on temperature control work are required for shop drawings, manufacturer's data, operating instructions, maintenance manuals, wiring diagrams and the system guarantee and product warranties.

PART 2 - CONTROLS

2.1 DAY-NIGHT INDEXING:

A. A direct digital controller shall provide the automatic signals for occupied or unoccupied control. For each zone listed below, provide a software graphical user interface that allows authorized maintenance personnel to select or override the automatic signals for occupied or unoccupied control on the building management system user interface. An alarm shall be generated on the Facility Management System (FMS) when the Zone is selected as "Override". The new zones for this building shall be as follows:

1. ZONE #AREA SERVED
    a. Cafeteria
    b. Library
    c. Gymnasium
    d. Classrooms
    e. Administration
    f. Kitchen

B. Whenever any zone is indexed to occupied cycle, the unit or units shall run continuously and shall be controlled as specified hereinafter. When indexed to the unoccupied cycle, the room sensors shall be reset to night temperature and shall cycle their respective units to maintain the setback or setup setpoints. In addition, whenever a classroom zone is indexed to the occupied cycle, the toilet exhaust fans shall operate. The toilet exhaust fans shall be off during the unoccupied cycle.

2.2 CYCLES:

A. **Night (Unoccupied):** When any zone is indexed to the night cycle, all air handling units and rooftop units within the zone shall stop, all thermostats shall be indexed to their night setting and shall control their respective units to cycle the unit to maintain a reduced space temperature. During this cycle all associated exhaust fans shall be stopped and all associated outdoor and relief dampers shall be closed. When indexed to the occupied cycle, the units shall run continuously and shall be controlled as specified hereinafter. The automatic occupied - unoccupied signals shall incorporate an adaptive optimum start algorithm that shall utilize both the zone temperature and the outside air temperature to start the mechanical equipment so as to reach occupied temperature targets just in time for occupancy.

B. **Day (Unoccupied)**: When any zone is indexed to the day cycle, but the occupancy sensor describes the space as unoccupied, the space may go into a day-unoccupied cycle. During this cycle all associated outdoor dampers shall be closed and the unit shall run intermittently as required to maintain the space temperature. The temperature set-point shall be identical to the set-point in occupied mode. The occupied and unoccupied statuses shall be determined through a relay to the space's occupancy sensor. The sensor shall be provided by the E.C. with a relay for this connection. The connection and wiring to the BAS shall be provided by this Contractor.

C. **Occupied**: When any zone is indexed to the day cycle, and the occupancy sensor describes the space as occupied, the space shall operate per the sequences described in the following sections.

D. **Warm Up:** For all air conditioning units and air handlers, provide the necessary devices required to keep the outside air dampers closed during the warmup cycle prior to occupancy as determined by the optimum start algorithm.

2.3 VAV HOT/CHILLED WATER ROOFTOP AIR HANDLING UNIT CONTROL

A. Air Handlers are equipped with outside air/return air dampers, face and bypass dampers across the heating coil, hot water control valves, and chilled water control valves. Air handler shall be indexed to the occupied, unoccupied day, unoccupied night and warmup modes from the Facility Management System (FMS) along with the respective zone.

B. Fan Speed Control: For each system provide a supply duct static pressure sensor located 2/3 out the distance of the main supply air duct that shall act, through the DDC controller, to modulate the speed of the supply air fan via the VFD in order to maintain a constant supply duct static pressure. Unit shall always be started at minimum speed and ramp up gradually to the required airflow.

C. Warmup Cycle: When in the heating mode, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the air handler on full heat and full return air in order to bring the return air temperature up to occupied set-point. Heating valve shall be open through the coil, and face damper shall be open and outside air damper shall be closed.

D. Occupied Cycle:

1. The supply fan shall run continuously during the occupied cycle. When in the heating mode, the outdoor air damper shall first open to minimum position as set in the Facility Management System. On a fall in supply air temperature below the heating set-point, the hot water valve shall modulate open through the coil and the outside air damper remains at minimum position. On a rise in supply air temperature, the hot water valve shall modulate closed.
2. Whenever the outside air temperature falls below 38 degF, the hot water control valve shall open fully and only the face and bypass dampers shall be modulated as required to maintain the heating set-point. Whenever the outside air temperature rises above 40 degF, the face damper shall fully open, the bypass damper shall fully close and the hot water heating control valve shall be modulated through the coil as required to maintain the heating set-point.
3. On a continued rise in supply air 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 supply air temperature, the chilled water valve shall be modulated open through the coil to maintain discharge temperature. On a fall in supply air temperature, the reverse shall occur.
4. If free cooling is not available, the outside air damper shall remain at minimum open position and just the chilled water valve shall be modulated open for cooling as required.

E. Unoccupied Cycle: The outside air dampers shall remain closed while the fan cycles with the hot water valve and chilled water valve to maintain the adjustable setback and setup set-points at a designated night zone temperature sensor. During day-unoccupied mode the set-points shall not be setback.

F. Safeties:

1. During both occupied and unoccupied cycles, an averaging air temperature sensor shall act to override the heating coil face and bypass dampers and control valve as required in order to maintain the adjustable low limit set-point of 55 degF.
2. For units with capacity greater than or equal to 2000 CFM, duct smoke detector(s) shall be furnished by the Electrical Contractor and installed by the Heating Contractor. Power wiring to duct detector(s) shall be provided by the Electrical Contractor and control shutdown wiring shall be provided by the FMS Contractor. Upon sensing the products of combustion, the fan shall be de-energized, the outside air damper shall be closed, the heating and cooling shall be off and an alarm message shall be generated on the Facility Management System.
3. Provide a temperature low limit with 20' serpentined element responsive to the coldest 1' length in the discharge of the unit heating coil. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the unit heating coil control valve, close the chilled water control valve and generate an alarm on the FMS. The low limit will not require a manual reset at the device before the unit can be restarted.
4. All sensor inputs and actuator outputs from the controller shall be available throughout the Facility Management System.

G. 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 AHU controller.

3. When the OA temperature is warmer than 65°F (adj), the SAT set-point shall be 55°F (adj).
4. When the OA temperature is colder than 55°F (adj), the SAT set-point shall be 65°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 65°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.).
9. Once return air humidity drops 5% below set-point the unit can follow the discharge air temperature reset sequences that are outlined.

H. Safeties:

1. 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.
2. Provide a temperature low limit with 20' serpentined element responsive to the coldest 1' length in the inlet of the unit cooling coil. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the recirculation damper, open the unit heating coil control valve, close the chilled water control valve and generate an alarm on the BAS. The low limit will require a manual reset at the device before the unit can be restarted.

I. Room Sensors:

1. All sensor inputs and actuator outputs from the controller shall be available throughout the Building Automation System.

J. Filter Status: Provide a pressure switch to monitor the differential pressure across the filter(s) when the supply fan is operating. If the switch closes for 2 minutes after a request for fan operation, a dirty filter alarm shall be annunciated.

K. Supply and Exhaust Fan Operation: Fan status shall be monitored through the VFD. If the fan does not start within 30 seconds after a request for fan operation, a fan failure alarm shall be annunciated and the unit will shut down, requiring a manual reset to re-start the unit. Provide a high static pressure sensor to monitor the differential pressure across each fan. If the duct static pressure reaches 5.0 in.H2O (adj), the unit shall shut down, requiring a manual reset to re-start the unit.

2.4 ENERGY RECOVERY UNIT

A. Energy recovery units are equipped with outside air/return air dampers, recirculation dampers, exhaust dampers, recovery device bypass dampers and hot water heating/chilled water coils with

valve control. Units shall be indexed to the occupied, unoccupied and warmup modes from the Facility Management System (FMS) along with the respective zone.

B. Warmup Cycle: When in the heating mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the heating and recovery unit on full heat and full return air in order to bring the temperature up to occupied set-point. Heating valve shall be open, outside air damper shall be closed, exhaust damper shall be closed and recirculation damper shall be open. The exhaust fan shall remain off and the energy recovery wheel shall rotate at its minimum speed.

C. Cool-Down Cycle: When in the cooling mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the heating and recovery unit on full cooling and full return air in order to bring the temperature down to occupied set-point. Cooling valve shall be open, outside air damper shall be closed, exhaust damper shall be closed and recirculation damper shall be open. The exhaust fan and energy recovery wheel shall remain off. If conditions are appropriate for economizing (as described in the occupied sequence) the economizer function shall be engaged.

D. Occupied Cycle:
1. The supply fan shall run continuously during the occupied cycle and the exhaust fan shall modulate to maintain a slightly positive pressure relationship between the space and neutral conditions. The energy recovery wheel shall run continuously. After fan operation is proved, the outdoor air damper shall first open to minimum position as set in the Facility Management System. In the heating mode, on a fall in space temperature below the heating set-point the energy recovery device will see full flow (the wheel shall operate at full speed) to maximize heat recovery. On a continued fall in space temperature below the heating set-point the hot water valve shall modulate open while the outside air damper remains at minimum position. On a rise in space temperature, the hot water valve shall modulate closed. On a continued rise in temperature the energy recovery bypass damper shall open (and the energy recovery wheel shall slow to its minimum speed).
2. When in the cooling mode, the outdoor air damper shall be at minimum position and on a rise in space temperature, the chilled water valve shall be modulated open for cooling. On a fall in space temperature, the reverse shall occur.
3. If the OA temperature drops below the frost threshold set-point (adj) the recovery device bypass damper will modulate to maintain the exhaust-side leaving temperature at set-point. If the recovery device bypass damper reaches 100% open for 5 minutes the wheel will be disabled to prevent frosting.
4. The airside economizer is enabled whenever the OA enthalpy is lower than the RA enthalpy. When economizing is enabled and the ERU is cooling, the OA damper is modulated between its current minimum position and 100% open to maintain discharge air temperature at set-point. The energy recovery bypass damper shall open (and the wheel shall spin at its minimum speed) If the mixed air temperature drops below 53°F (adj), the OA damper begins to close, the recovery bypass dampers begin to close, and the wheel speed increases; at 50°F (adj) the OA damper will be at minimum position, the energy recovery bypass dampers will be closed and the wheel will be operating at full speed to maximize recovery. The hydronic cooling valve will remain closed until the OA damper has reached 100% open for 5 minutes (adj).
5. If free cooling is not available as determined by outdoor air enthalpy, the outside air damper shall remain at minimum open position, the energy recovery bypass dampers will be closed,

the wheel will be operating at full speed to maximize recovery and just the chilled water valve shall be modulated open for cooling as required.

6. Dehumidification: Upon a rise in humidity above the upper limit of 60% RH (Adjustable), the humidity sensor shall ramp down the supply and exhaust fan speed to 60% of the design airflow when and modulate open the chilled water valve to maintain space humidity levels while maintaining zone CO2 levels and temperature. On a further rise in humidity, the supply and exhaust fan shall ramp to the indicated airflow on the drawing, the chilled water valve shall open to full position and the heating coil valve shall modulate to maintain space temperature.

7. Demand Control Ventilation: Provide a carbon dioxide space sensor to monitor carbon dioxide levels and generate an alarm on elevated levels. The unit's outdoor air damper shall modulate closed below minimum (and the recirculation damper shall modulate open in tandem) when carbon dioxide levels are less than 800 ppm, unless the unit is in economizer operation mode.
8. Single-Zone VAV Operation: When temperature, humidity and carbon dioxide levels sensed are all within satisfactory levels the unit shall drop back into an energy-saving single zone VAV function. This operation will reduce the unit’s airflow to 60% of its scheduled airflow. When temperature, humidity or carbon dioxide levels are not within acceptable parameters normal operation shall occur.

E. Unoccupied Cycle:
1. The outside air and exhaust dampers shall remain closed and the recirculation damper shall be open while the supply fan cycles with the hot water and chilled water valves to maintain the adjustable setback and setup set-points. The exhaust fan shall remain off and the energy recovery wheel shall rotate at its minimum speed.
2. Dehumidification: Upon a rise in humidity above the space humidity set-point, the chilled water valve shall open fully and the hot water valve shall modulate (reheat) to maintain space temperature. Upon a drop in space humidity, normal valve control shall be restored.

F. Safeties:
1. 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 Facility Management System.
2. Provide a temperature low limit with 20' serpentined element responsive to the coldest 1' length in the discharge of the unit heating coil. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the recirculation damper, open the unit heating coil control valve, close the chilled water control valve and generate an alarm on the FMS. The low limit will require a manual reset at the device before the unit can be restarted.

G. Room Sensors:

1. All sensor inputs and actuator outputs from the controller shall be available throughout the Direct Digital Control System.

H. 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.

I. Supply and Exhaust Fan Operation: A pressure switch will monitor the differential pressure across each fan. If the switch does not open within 30 seconds after a request for fan operation, a fan failure alarm will be annunciated and the ERU will stop, requiring a manual reset to re-start the ERU. If the supply duct static pressure reaches 5.0 in.H2O (adj), the high limit pressure switch will shut down the ERU, requiring a manual reset to re-start the ERU.

2.5 SHUTOFF VAV BOX CONTROL:

A. The VAV box is to be controlled independent of system pressure fluctuations by an application specific DDC controller using electric actuation. The space served by the VAV box is controlled in Occupied and Unoccupied as indexed by the FMS according to its respective zone signal.

B. During the unoccupied cycle the VAV box primary air damper shall be allowed to be fully closed. During day-unoccupied mode the set-points shall not be setback.

C. During the Occupied cycle, the VAV box primary air damper is controlled within user defined occupied maximum and minimum supply air volume settings. The controller monitors the room temperature sensor and air velocity sensor and modulates the primary supply air damper in sequence with the hot water reheat coil control valve to maintain the room temperature at set-point. While the reheat coil is being utilized for heating, the box primary supply damper shall remain at the minimum design CFM. When the boilers are not in operation, the air flow minimum setting shall be zero and reheat shall not be used.

D. Room Sensors:

1. The room temperature sensor shall have a concealed set-point adjustment slide knob with software definable adjustment range. The room sensor shall have no indication of room temperature readout. The set-point adjustment slide know shall read + for warmer and - for cooler and shall be color coded red for warmer and blue for cooler.
2. All sensor inputs and actuator outputs from the controller shall be available throughout the Direct Digital Control System.

2.6 EXHAUST FAN CONTROL:

A. Those exhaust fans noted "Occ/Unocc" on the Exhaust Fan schedule shall run during occupied cycle and remain off during unoccupied cycle of their respective zone. The exhaust fans shall be controlled via spare binary outputs of local DDC controllers such that they can be overridden on/off through the Facility Management System.

B. Those exhaust fans noted "T'stat" on the schedule shall be controlled based upon a space temperature sensor via the DDC system. Upon a rise in space temperature, the exhaust fan shall run and any associated intake or exhaust dampers shall open (where applicable). On a fall in space temperature, the reverse shall occur.

C. For exhaust fans associated with a kitchen hood provide all necessary wiring, switches and interlocks to energize the fan from a switch located on the exhaust hood. Fans shall also be energized by a heat sensor located in the kitchen hood. All sensors, relays, and wiring required

for a complete system shall be provided by this Contractor. "All" includes the lights and line voltage wiring.

D. Those exhaust fans noted "Switch" fan shall be operated by a manual on/off switch provided by the H.C. and installed by the E.C. A separate thermostat will be provided where noted on the schedule drawings. If high temperatures are sensed in the exhaust fan shall energize regardless of the status of the manual switch.

2.7 CABINET UNIT HEATER CONTROL:

A. Provide a remote space temperature sensor for control of each cabinet unit heater. The sensor shall be controlled through the DDC system and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall cycle the cabinet heater fan to maintain the day or night temperature set-point. Any time that the unit fan is energized, the two position hot water control valve shall open.

2.8 UNIT HEATER CONTROL:

A. Provide a remote space temperature sensor for control of each unit heater. The sensor shall be controlled through the DDC system and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall cycle the heater fan to maintain the day or night temperature set-point. Any time that the unit fan is energized, the two position hot water control valve shall open.

2.9 CONVECTOR CONTROL:

A. Provide a remote space temperature sensor for control of each convector. The sensor shall be controlled through the DDC system and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall open the two-position hot water control valve to maintain the day or night temperature set-point.

2.10 DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS:

A. Install and wire the thermostat provided by the unit manufacturer. In each area provide a temperature sensor to generate an alarm on the FMS if elevated temperatures are sensed.

2.11 HEATING PUMPS:

A. The heating pump pair shall be commanded to run continuously through the FMS according to the lead/lag control described below.

2.12 LEAD/LAG SELECTION OF HOT WATER AND CHILLED WATER PUMPS:

A. Lead pump selection shall be through manual 3-position switches (e.g. Pump 1 - Off - Pump 2) on the boiler room ATC panel. Upon lead pump failure as sensed by a water flow switch and after an adjustable time delay, the lag pump shall be energized and the lead pump shall be locked out either through the starter or the respective VFD. An alarm shall be generated on the mechanical room DDC panel. Also, an alarm message shall be generated on the FMS network.

Pump commands, lead pump selection and flow statuses shall be available throughout the network. Lead/Lag shall be alternated by the Building Management System on a weekly basis.

2.13 BOILERS:

A. When the heating system is energized, the lead main heating pump shall operate. The control valve on the lead boiler shall open and the lead boiler shall be commanded to operate. Provide a signal to the boiler to control the percentage of firing to maintain the desired loop temperature as follows:

1. 35 F and lower outdoor air temperature - 140 F water temperature (adjustable).
2. 70 F and higher outdoor air temperature - 120 F water temperature (adjustable).

B. Should the lead boiler fail to maintain the scheduled temperature, open the valve for the lag boiler, and energize the lag boiler to maintain the scheduled loop water temperature, de-energize the lead boiler, close its control valve, and generate an alarm on the FMS.

C. Communication to the boilers shall be via the boilers' MODBUS port. The boiler manufacturer shall provide a gateway for communicating with this port if required.

D. Display all points available from the boilers on the FMS.

2.14 CARBON MONOXIDE SENSOR:

A. Provide a carbon monoxide detection panel with remote sensor in the boiler room. Panel shall generate a local audible and visual alarm. Remote alarms shall be provided and shall be visual only. Generate an alarm on the FMS should carbon monoxide be sensed.

2.15 NATURAL GAS LEAK DETECTION PANEL:

A. Provide a natural gas leak detection panel and 2 remote sensors in the boiler room. Panel shall generate an alarm on the FMS should natural gas be sensed. Shut down all gas fired equipment if a leak is detected.

2.16 BURNER KILL SWITCHES:

A. Provide two (2) burner kill switches. When any of the switches are switched to the off position the boilers shall be de-energized and an alarm shall be generated on the FMS.

2.17 THERMOSTAT GUARDS:

A. Provide guards over thermostats in vestibules, cafeteria, gymnasium, corridors, student toilet rooms, and other similar unsupervised spaces.

2.18 ALARMING:

A. Any alarm that the Owner defines as critical shall initiate an alarm to the remote Operator Workstation and shall generate an alarm message there. Utilize the District's Ethernet communications and data system.

2.19 CHILLER PLANT:

A. The chiller plant shall be enabled by the FMS whenever the outside air temperature is 60°F (Adjustable). or above and systems in the facility are in the OCCUPIED mode of operation. On a fall in outside air temperature below 55° F(Adjustable), the chilled water plant will be disabled (Chillers, and Pumps Off).

B. Chilled Water Pumps: When the chiller plant is enabled, the primary and secondary chilled water pumps shall be enabled. The secondary chilled water pump upon startup, the lead pump will be at minimum speed. The speed of the lead secondary chilled water pump will be modulated through the FMS to maintain the differential pressure set-point at two locations out in the chilled water system . Upon lead pump failure of either the primary or secondary chilled water pump and after an adjustable time delay; the lag pump will be energized and the lead pump will be locked out. An alarm will be recorded and annunciated at the operator work station. The lead pump will be selectable from the FMS panel. The primary pump shall modulate through its VFD to track the secondary pump, but not below the chiller's minimum flow.

C. Control :

1. Chiller, once enabled, shall operate under control of their manufacturer installed control system. Flow shall be proven in the chilled water system before a chiller is started.
2. The chiller control system shall be interfaced to the FMS system via a Bacnet interface provided by the chiller manufacturer.
3. The interface shall pass alarms generated by the chiller control system to the FMS.
4. The chilled water set-point shall be a writeable point on the FMS.

2.20 EMERGENCY GENERATOR:

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

B. Provide time delay relays to stagger start-up of equipment on emergency power according to the following schedule:

1. Step 1 (Instantaneous) Emergency Lights, Fire Alarm, Intercom, IDF/MDF Equipment, ATC Control Panels
2. Step 2 (30 Second Delay) Boilers, Heating Pumps, Boiler Control Panel
3. Step 3 (30 Second Delay) IDF/MDF DSS/CU, Heat Trace to CHL, CHL Basin Heater, Walk-in Freezer and Refrigerator Condensing Units, Cabinet Heater Fans, Unit Heater Fans, Sump Pump, RTU-1.

2.21 VARIABLE FREQUENCY DRIVES:

A. Monitor status of drive for HOA position and drive output.

B. Provide alarm if drive is in the hand position.

2.22 CLASSROOM UNIT VENTILATOR CONTROL

A. Unit ventilators are equipped with outside air/return air dampers and hot water heating/chilled water coil with valve control. Air handler shall be indexed to the occupied, unoccupied-day, unoccupied-night and warmup modes from the Facility Management System (FMS) along with the respective zone.

B. Warmup Cycle: When in the heating mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the unit ventilator on full heat and full return air in order to bring the temperature up to occupied set-point. Heating valve shall be open and outside air damper shall be closed.

C. Occupied Cycle:

1. The supply fan shall run continuously during the occupied cycle. The outdoor air damper shall first open to minimum position as set in the Facility Management System. In the heating mode, on a fall in space temperature below the heating set-point, the hot water valve (0-10V DC) shall modulate open through the coil while the outside air damper remains at minimum position. On a rise in space temperature, the hot water valve shall modulate closed.
2. Whenever the outside air temperature falls below 38 degF, the hot water control valve shall open fully and only the face and bypass dampers shall be modulated as required to maintain the heating set-point. Whenever the outside air temperature rises above 40 degF, the face damper shall fully open, the bypass damper shall fully close and the hot water heating control valve shall be modulated through the coil as required to maintain the heating set-point.
3. When the space temperature is below the heating set-point the hot water control valve shall modulate as required to maintain the heating set-point.
4. On a continued rise in space temperature above the cooling set-point , the outside air damper shall modulate open for cooling. When in the cooling mode, the outdoor air damper shall be at minimum position and on a rise in space temperature, the chilled water valve (0-10V DC) shall be modulated open through the coil for cooling. On a fall in space temperature, the reverse shall occur.
5. If free cooling is not available, the outside air damper shall remain at minimum open position and just the chilled water valve shall be modulated open through the coil for cooling as required.
6. Dehumidification: Upon a rise in humidity above the space humidity set-point, the chilled water valve shall open fully and the face and bypass dampers shall modulate to maintain space temperature. Upon a drop in space humidity, normal control shall be restored.

D. Unoccupied Cycle:

1. The outside air dampers shall remain closed while the fan cycles with the hot water and chilled water valves to maintain the adjustable setback set-points. During day, unoccupied mode the set-points shall not be setback.
2. Dehumidification: Upon a rise in humidity above the space humidity set-point, the chilled water valve shall open fully and the face and bypass dampers shall modulate to maintain space temperature. Upon a drop in space humidity, normal control shall be restored.

E. Safeties:

1. For units with capacity greater than or equal to 2000 CFM, duct smoke detector(s) shall be provided. Power wiring to duct detector(s) shall be and control shutdown wiring shall be provided. Upon sensing the products of combustion, the fan shall be de-energized, the outside air damper shall be closed, the heating and cooling shall be off and an alarm message shall be generated on the Facility Management System.
2. Provide a temperature low limit with 20' serpentined element responsive to the coldest 1' length in the discharge of the unit heating coil. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the unit heating coil control valve, close the chilled water control valve and generate an alarm on the FMS. The low limit will not require a manual reset at the device before the unit can be restarted.

F. Room Sensors:

1. The room temperature sensor shall have a concealed setpoint adjustment knob with software definable adjustment range (e.g. +/- 2 degF).
2. All sensor inputs and actuator outputs from the controller shall be available throughout the Facility Management System.

2.23 FAN COIL UNIT:

A. Fan coil units are equipped with supply fans, hot water heating coils, chilled water cooling coils, and return air filters. Fan coils shall be indexed to the occupied, unoccupied, warmup, and cool-down modes from the Building Automation System (BAS) along with the respective zone.

B. Warmup Cycle: When in the heating mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the unit on full heat in order to bring the temperature up to occupied set-point. Heating valve shall be open and modulate closed as the space reaches temperature.

C. Cool-Down Cycle: When in the heating mode of operation, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the unit on full cooling in order to bring the temperature down to occupied set-point. Cooling valve shall be open and modulate closed as the space reaches temperature.

D. Occupied Cycle:
1. The supply fan shall run continuously during the occupied cycle.
2. The associated ATC damper shall open.
3. On a fall in space temperature below the heating set-point, the hot water valve shall modulate open. On a rise in space temperature, the hot water valve shall modulate closed.
4. On a further rise in space temperature, the chilled water valve shall modulate open.

E. Unoccupied Cycle:
1. The associated ATC damper shall close.
2. The fan shall cycle with the hot water and chilled water valves to maintain the adjustable setback set-points.

F. Room Sensors:

1. All sensor inputs and actuator outputs from the controller shall be available throughout the Building Automation System.

G. Filter Status: A pressure switch will monitor the differential pressure across the filter when the supply fan is operating. If the switch closes for 2 minutes after a request for fan operation, a dirty filter alarm will be annunciated.

2.24 WALK-IN FREEZER AND COOLER:

A. Monitor the freezer and cooler temperatures and indicate an alarm on the BAS if abnormal temperatures are sensed.

2.25 DOMESTIC HWH:

A. Provide a temperature sensor in the domestic water supply piping at the outlet of the water heaters to monitor temperature and indicate an alarm on the BAS if abnormal temperature is sensed. Interface to BACnet gateway provided by water heater manufacturer.

2.26 DOMESTIC WATER BOOSTER PUMPS:

A. Provide monitoring of domestic water booster pumps (on/off) through contacts on manufacturer control panel, and indicate an alarm on the BAS if a pump fails.

2.27 HEAT TRACE:

A. Provide a current sensing relay on each heat trace circuit to indicate status on the BAS.

2.28 ROOFTOP AIR HANDLING UNITS – DX VAV

A. Air handlers are equipped with outside air/return air dampers, hot water heating coil with face and bypass damper and valve control, DX cooling coils, compressors and condensing fans. Air handler shall be indexed to the occupied, unoccupied and warmup modes from the Facility Management System (FMS) along with the respective zone.

B. Fan Speed Control: For each system provide a supply duct static pressure sensor located 2/3 out the distance of the main supply air duct that shall act, through the DDC controller, to modulate the speed of the supply air fan via the VFD in order to maintain a constant supply duct static pressure. Unit shall always be started at minimum speed and ramp up gradually to the required airflow.

C. Warmup Cycle: When in the heating mode, for a period of time prior to the scheduled occupancy time as determined by the optimum start algorithm, operate the air handler on full heat and full return air in order to bring the 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.

D. Occupied Cycle:

1. The supply fan shall run continuously during the occupied cycle. Fan operation shall be proved. After fan operation is proved, the outdoor air damper shall first open to minimum position as set in the Facility Management System. On a fall in supply air temperature below the heating set-point, the hot water valve shall modulate open and the outside air damper remains at minimum position. On a rise in supply air temperature, the hot water valve shall modulate closed.
2. Whenever the outside air temperature falls below 38 degF, the hot water control valve shall open fully and only the face and bypass dampers shall be modulated as required to maintain the heating set-point. Whenever the outside air temperature rises above 40 degF, the face damper shall fully open, the bypass damper shall fully close and the hot water heating control valve shall be modulated through the coil as required to maintain the heating set-point.
3. The supply air temperature shall optimized to satisfy the room with the largest cooling demand.
4. 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.
5. 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.
6. 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.

E. Unoccupied Cycle:
1. The outside air dampers shall remain closed while the fan cycles with the hot water valves and DX cooling modulate to maintain the adjustable setback and setup set-points.
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.

F. 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 Facility Management System.
3. Provide a temperature low limit with 20' serpentined element responsive to the coldest 1' length in the discharge of the unit heating coil. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the return air damper, open the unit heating coil control valve and generate an alarm on the FMS. The low limit will require a manual reset at the device before the unit can be restarted.

G. 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.

H. 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.

2.29 STAND-ALONE FREEZERS AND COOLERS:

A. Monitor (6) stand-alone freezer and cooler temperatures and indicate an alarm on the BAS if abnormal temperatures are sensed.

PART 3 - EXECUTION:

3.1 INSTALLATION:

A. Refer to the 250554 section of these specifications.

3.2 TEST-ADJUST-BALANCE (TAB) COORDINATION AND ASSIST:

A. Include all labor for coordination and assistance to the TAB contractor for final system testing, adjusting and balancing.

END OF SECTION 230993

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water piping, above grade.

C. Chilled water piping, above grade.

D. Chilled water piping, below grade.

D. Equipment drains and overflows.

E. Pipe hangers and supports.

F. Unions, flanges, mechanical couplings, and dielectric connections.

G. Valves:

1. Gate valves.
2. Ball valves.
3. Butterfly valves.
4. Check valves.

1.2 RELATED REQUIREMENTS

A. Section 099000 - Painting and Coating.

B. Section 230516 - Expansion Fittings and Loops for HVAC Piping.

C. Section 230719 - HVAC Piping Insulation.

D. Section 232114 - Hydronic Specialties.

E. Section 232500 - HVAC Water Treatment:

1.3 REFERENCE STANDARDS

A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2013.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers; 2011.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; 2013.

E. ASME B31.9 - Building Services Piping; 2011 (ANSI/ASME B31.9).

F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2011a.

H. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2009).

I. ASTM B32 - Standard Specification for Solder Metal; 2008.

J. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.

K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005 (Reapproved 2011).

L. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2012.

M. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2009.

N. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2013.

O. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2006.

P. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).

Q. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).

R. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2013a.

S. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007.

T. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; 2011 and errata.

U. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2010.

V. AWWA C606 - Grooved and Shouldered Joints; 2011 (ANSI/AWWA C606).

W. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Welders Certificate: Include welders certification of compliance with ASME (BPV IX).

C. Product Data:

1. Include data on pipe materials, pipe fittings, valves, and accessories.
2. Provide manufacturers catalogue information.
3. Indicate valve data and ratings.
4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Valve Repacking Kits: One for each type and size of valve.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.

C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

D. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.

E. Coupling Manufacturer:

1. Victaulic
2. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.

3. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.

F. Welder Qualifications: Certify in accordance with ASME (BPV IX).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:

1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Grooved mechanical joints may be used in accessible locations only.
    a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
    b. Grooved mechanical connections and joints shall be Victaulic Zero Flex (rigid) couplings only.
    c. Use for couplings, tees, reducers, and elbows only.
    d. Provide proper gaskets for system working temperature and pressure.
4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated and as follows:

1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

2.2 PEX PIPE AND FITTINGS

A. Use is limited to 2 inch size and smaller.

B. PEX-a (Engle-method Crosslinked Polyethylene) Piping: ASTM 876 with oxygen-diffusion barrier that meets DIN 4726.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Uponor Wirsbo hePEX or a comparable product by one of the following:

1. Rehau
2. Mr. PEX

D. PEX-a Fittings, Elbows and Tees (½ inch through 2 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:

1. UNS No. C69300 Lead-free (LF) Brass
2. 20% glass-filled polysulfone as specified in ASTM D6394
3. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394
4. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
5. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394
6. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked “F1960”.

E. TRANSITION FITTINGS

1. Plastic-to-Metal Transition Fittings:
   a. Manufacturers: Provide fittings from the same manufacturer of the piping.
   b. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Editor: Use for PEX sizes 2 inch and below.
   c. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Use for PEX sizes 2 inch and below.
   d. Dezincification-resistant (DZR) Brass to PEX-a Transition: male NPT thread and PEX compression fitting. Use for PEX sizes 2½ inch through 4 inch.

2.3 TRANSITION UNIONS

A. Plastic-to-Metal Transition Unions:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. Threaded Brass to PEX-a Union: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Use for PEX sizes 2 inch and below.
3. Brass Sweat to PEX-a Union: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Use for PEX sizes 2 inch and below.

2.4 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings. 2 inch size and smaller.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings. Groove joints shall be as manufactured by Victaulic.

B. Copper Tube up to 2 inch size only: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
   a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, non toxic synthetic rubber sealing elements.

C. Manufacturers:

1. Grinnell Mechanical Products, a Tyco International Company: www.grinnell.com.
2. Viega LLC: www.viega.com.
3. Nibco

D. PEX Piping:

1. Hot-water heating piping, aboveground (2 inch and below) shall be the following:
   a. PEX-a piping, with F1960 cold-expansion fittings.

2.5 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:

1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1 welded.

2. Threaded Joints: ASME B16.3, malleable iron fittings. 2 inch size and smaller.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings. Grooved joints shall be as manufactured by Victaulic.

B. Copper Tube up to 2 inch size only: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
   a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, non toxic synthetic rubber sealing elements.
   a. Manufacturers:
      1) Grinnell Mechanical Products, a Tyco International Company: www.grinnell.com.
      2) Viega LLC: www.viega.com.
      3) Nibco

C. PEX Piping:

1. Chilled water piping, aboveground (2 inch and below) shall be the following:
   a. PEX-a piping, with F1960 cold-expansion fittings.
2. Hot-water heating piping, aboveground (2½ inch through 4 inch) shall be the following:
   a. PEX-a piping, with compression fittings.

2.6 CHILLED WATER PIPING, BURIED (BASE BID)

A. PVC Pipe: ASTM D 1785, Schedule 40, or ASTM D 2241, SDR 21 or 26.
1. Fittings: ASTM D 2466 or ASTM D 2467, PVC.
2. Joints: Solvent welded.

B. PVC Pipe sizes 8 inch (200 mm) and larger: ASTM D 1785, Schedule 80, or ASTM D 2241, SDR 21 or 26.
1. Fittings: ASTM D 2466 or ASTM D 2467, PVC.
2. Joints: Solvent welded.

2.7 CHILLED WATER PIPING, BURIED (ALTERNATE BID MC-B)

A. Outdoor chilled water pipes shall be factory fabricated, pre-insulated polyethylene jacketed, polyurethane insulated products similar to Thermacor Thermafab system. The products shall be installed in accordance with the manufacturer's recommendations.

1. Service: Chilled water piping system.
2. Chilled water pipe: ASTM A53B, ERW, Standard weight steel in DRL's.
3. Fittings: Pre-fabricated/pre-insulated. Bolster pads used for expansion as required. Tees and long radius 90 EL/45 butt weld fittings conforming to ASTM A-234 and ANSI B16.19. Minimum 2D radius bends used where possible, complying with ASME B31.1.
4. Insulation: Polyurethane, 90% minimum closed cell content, minimum 2.0 to 3.0 pcf, K=0.16@ 75 deg F. Compressive strength of not less than 40 PSI. Insulation operating temperature not to exceed 250F. Insulation thickness tolerance +/- 1/8" on ends and 1/4" in middle.
5. Jacket: Extruded black, high-density polyethylene (HDPE) manufactured in accordance with ASTM D-3350, minimum 12 mils thickness.
6. Field joint insulation: Polyurethane foam, HDPE sleeve and heat shrink sleeve.
7. Fitting insulation: Factory applied polyurethane foam with a molded or mitered PE fitting cover.
8. Installation shall be supervised by local field service technician.

B. Outdoor chilled water pipes shall be factory fabricated, PP-R polypropylene SDR-11 as manufactured by Aquatherm "Blue". System shall carry NSF 14, ICC, ASTM F 2389, IAPMO, UMC, IMC, and CSA B137.11 certifications.

2.7 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

B. PVC Pipe: ASTM D1785, Schedule 40. Do not use in air plenum spaces.

1. Fittings: ASTM D2466 or D2467, PVC.
2. Joints: Solvent welded in accordance with ASTM D2855.

2.8 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Under:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 Inches:

1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Gaskets: 1/16 inch thick preformed neoprene.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Mechanical Couplings: Comply with ASTM F1476.
   3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
   4. Gasket Material: EPDM suitable for operating temperature range from -30 degrees F to 230 degrees F.
   5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
   6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
   7. Manufacturers:
      a. Victaulic Company: www.victaulic.com.

D. Dielectric Connections:

   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600 volt breakdown test.
      c. Construct of galvanized steel with threaded end connections to match connecting piping.
      d. Suitable for the required operating pressures and temperatures.

2.9 GATE VALVES

A. Manufacturers:

   1. Nibco, Inc: www.nibco.com.
   2. Crane.
   3. Stockham
   4. Victaulic

B. Over 3 Inches:

   1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

2.10 BALL VALVES

A. Manufacturers:

   1. Nibco, Inc: Model #580-70-66: www.nibco.com.
   2. Crane
   3. Stockham
   4. Victaulic Company: www.victaulic.com.

B. Up to and including 3 inches:

1. Bronze two piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends with union.
2. Provide Nib-seal with extended handles for chilled water lines.

2.11 BUTTERFLY VALVES

A. Manufacturers:

1. Nibco #3010
2. Crane Co.
3. Jamesbury
4. Victaulic

B. Body: Ductile iron with resilient replaceable EPDM seat, lug ends, extended neck, extended neck, 250 psi.

C. Disc: Construct of chrome plated ductile iron.ASTM A-395.

D. Stem: Stainless steel with stem offset from the centerline to provide full 360 degree circumferential setting.

E. Operator: Infinite position lever handle with memory stop. Over 6" size, gear operator.

F. Contractor shall include an allowance for four additional 4" butterfly valves.

2.12 SWING CHECK VALVES

A. Manufacturers:

1. Nibco, Inc: www.nibco.com.
2. Crane
3. Stockham
4. Victaulic Company: www.victaulic.com.

B. Up To and Including 2 Inches:

1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.

C. Over 2 Inches:

1. Iron body, bronze trim, bronze swing disc, renewable disc and seat, flanged ends.

2.13 CALIBRATED BALANCING VALVES:

A. MANUFACTURERS: Subject to compliance with requirements, provide products by one of the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Bell & Gossett Model CS Plus

C. Armstrong Pump Model CBV

D. Flow Design Inc. Model UA

E. Nutech Model MB/MBF/MBG

F. Victaulic/Tour & Anderson STA Series.

1. Venturi Type Balancing Valves : 1/2" to 2"
   a. Venturi type design, bronze body, chrome plated ball, EPDM seals. Provide pressure and temperature test ports across valve measurement area. Ports to be fitted with dual durometer EPDM cores, brass cap and O-ring seal. Valves to have drain/purge port. Valve end connections to suit the piping system. Provide valve with memory stop and calibrated position indicator. Valves to be rated at 600 PSI at 2500 F. and be 100% positive shut-off. Measurement accuracy to be +/-3% of flow rate.
2. Venturi Type Balancing Valves :2-1/2" to 12"
   a. Venturi type design, cast carbon steel/ductile iron body, SS steam, EPDM seat and Buna seals. Provide memory stop and calibrated position indicator. Valves to be rated at 200 PSIG at 250F. and be 100% positive shut-off. Measurement accuracy to be +/-3 of flow rate.
3. Stainless for pool water system.
4. Globe Style Valves ½" to 2": to have Y-pattern, Ametal® brass copper alloy body providing dielectric protection rated to 300 PSI at 250 deg F. EPDM o-ring seals, 4-rurn digital readout hand wheel for balancing and concealed memory feature with locking, tamper-proof setting. Built-in check valve provided for connecting a portable differential pressure meter for flow reading capabilities, soldered or threaded ends. Valve does not require a separate shutoff valve. Victaulic/Tour & Anderson Series 786, 787, and 78K.
   a. Coil Components: Install Victaulic Series 78U or Nutech series URP/US union port fitting with manual air vent ,PT tap and or drain valve, Victaulic Series 78Y or Nutech series SV strainer/ball valve with PT tap & drain valve with cap and strap or Victaulic Series 78T or Nutech series SB union/ball valve combination with PT and drain valve with cap & strap to complete terminal hookup at coil outlet. (Note: 78T or SB only to be used when 78Y or SV is not required).
   b. Globe Style Valves 2-1/2" to 16": to have Y-pattern ductile iron body rated to 350 PSI at 250 deg F. EPDM o-ring seals, multiple-turn digital readout hand wheel for balancing and concealed memory feature with locking, tamper-proof setting. Built-in check valve provided for connecting a portable differential pressure meter for flow reading capabilities, grooved or flanged ends. Valve does not require a separate shutoff valve. Victaulic/Tour & Anderson Series 788 and Series 789.

c. Installer shall consult with Victaulic representative for proper presetting of valve to provide designed flows. Note: If using Nutech products no presetting is required.
   1) Schedule: Balancing Valves/Coil Kits: Supplier to provide complete schedule with product selection, valve sizes (which shall be the same as the pipe size), flow rates and differential pressure at design flow for each location/coil.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and to avoid interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Sleeve pipe passing through partitions, walls and floors.

G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 7.

H. Slope piping and arrange to drain at low points.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.

3.3 GROOVED JOINTS:

A. Install in accordance with the manufacturer's latest published installation instructions.

B. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.

3.4 INSERTS:

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

1. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.5 PIPE HANGERS AND SUPPORTS:

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-89.

B. Support horizontal piping as scheduled.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Provide copper plated hangers and supports for copper piping.

I. Prime coat exposed steel hangers and supports. Refer to Division 9. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.

K. Use eccentric reducers to maintain top of pipe level.

L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

M. Install valves with stems upright or horizontal, not inverted.

3.6 SCHEDULES

A. Hanger Spacing for Copper Tubing.

1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Steel Piping.

1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.

C. Hanger Spacing for Plastic Piping.

1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.

D. Hanger Spacing for PEX Piping:

1. PEX-a Piping Hanger Spacing: Install hangers for PEX-a piping with the following maximum spacing:
   a. 1 inch and below: Maximum span, 32 inches.
   b. 1¼ inch and above: Maximum span, 48 inches.
2. PEX-a Piping Hanger Spacing with PEX-a Support Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations, with the following maximum spacing:
   a. 1. Maximum span, 8 feet.
3. PEX-a Riser Supports: Install CTS riser clamps at the base of each floor and at the top of every other floor. Install mid-story guides between each floor.

E. PEX PIPE JOINT CONSTRUCTION

1. PEX-a Connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for F1960 connections.

F. PEX PIPE FIELD QUALITY CONTROL

1. Do not expose PEX piping to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of piping exposed to direct sunlight.

G. PEX PIPE WARRANTY

1. PEX-a manufacturer system warranty shall cover tubing for a duration of 30 years from the date of installation.

END OF SECTION 232113

SECTION 232114 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Expansion tanks.

B. Air vents.

C. Air separators.

D. Strainers.

E. Suction diffusers.

F. Combination pump discharge valves.

G. Balancing valves.

H. Flow meters.

I. Relief valves.

J. Pressure reducing valves.

1.2 RELATED REQUIREMENTS

A. Section 23 21 13 - Hydronic Piping.

B. Section 23 25 00 - HVAC Water Treatment: Pipe Cleaning.

1.3 REFERENCE STANDARDS

A. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2013.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.

D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

E. Maintenance Contract.

F. Project Record Documents: Record actual locations of flow controls.

G. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

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

1. See Division 1 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 EXPANSION TANKS

A. Manufacturers:

1. Amtrol Inc: www.amtrol.com.
2. ITT Bell & Gossett: www.bellgossett.com.
3. Taco, Inc: www.taco-hvac.com.

B. Construction: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.

C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi.

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.2 AIR VENTS

A. Manufacturers:

1. ITT Bell & Gossett: www.bellgossett.com.
2. Taco, Inc: www.taco-hvac.com.
3. Amtrol

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

2.3 AIR SEPARATORS

A. Combination Air Separators/Strainers:

1. Manufacturers:
   a. Armstrong International, Inc: www.armstronginternational.com.
   b. ITT Bell & Gossett: www.bellgossett.com.
   c. Taco, Inc: www.taco-hvac.com.
2. Steel, tested and stamped in accordance with ASME (BPV VIII, 1); for 125 psi operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 STRAINERS

A. Manufacturers:

1. Armstrong International, Inc: www.armstronginternational.com.
2. Green Country Filtration.
3. WEAMCO

B. Size 2 inch and Under:

1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:

1. Provide flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:

2.5 SUCTION DIFFUSERS

A. Manufacturers:

1. ITT Bell & Gossett; www.bellgossett.com.

2. Victaulic Company of America; www.victaulic.com.

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.6 COMBINATION PUMP DISCHARGE VALVES

A. Manufacturers:

1. ITT Bell & Gossett
2. Crane Co.: www.cranevalve.com.
3. Taco, Inc: www.taco-hvac.com.
4. Victaulic Company of America: www.victaulic.com.

B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.7 FLOW METERS

A. Manufacturers:

1. ITT Bell & Gossett
2. Approved equal

B. Orifice principle by-pass circuit with direct reading gage, soldered or flanged piping connections for 125 psi working pressure, with shut off valves, and drain and vent connections.

C. Direct reading with insert pitot tube, threaded coupling, for 150 psi working pressure, maximum 240 degrees F, 5 percent accuracy.

D. Calibrated, plug type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer.

E. Portable meter consisting of case containing one, 3 percent accuracy pressure gage with 0-60 feet pressure range for 500 psi maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

2.8 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.9 PRESSURE REDUCING VALVES

A. Manufacturers:

1. Armstrong International, Inc; Model www.armstronginternational.com.
2. ITT Bell & Gossett; Model www.bellgossett.com.

B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 21 13.

C. Materials of Construction:

1. Valve Body: Constructed of bronze.
2. Internal Components: Construct of stainless steel and engineered plastics or composition material.

D. Connections:

1. NPT threaded: 0.50 inch, or 0.75 inch.

E. Provide integral check valve and strainer.

F. Maximum Inlet Pressure: 100 psi.

G. Maximum Fluid Temperature: 180 degrees F.

H. Operating Pressure Range: Between 10 psi and 50 psi.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Where large air quantities can accumulate, provide enlarged air collection standpipes.

C. Provide manual air vents at system high points and as indicated.

D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

E. Provide valved drain and hose connection on strainer blow down connection.

F. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

G. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.

H. Support pump fittings with floor mounted pipe and flange supports.

I. Pipe relief valve outlet to nearest floor drain.

J. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 232114

SECTION 232117 - PIPE HANGERS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section specified hangers, supports and anchors for use in piping systems installed in other sections of these specifications.

1.2 RELATED SECTIONS:

A. Section 23 2113 - Hydronic Piping

PART 2 - PRODUCTS

2.1 HORIZONTAL PIPING HANGERS AND SUPPORTS:

A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information: size hangers and supports properly for piping including insulation, if any.

B. Adjustable Band Hangers: MSS Type 7, fabricated from steel.

C. Adjustable Swivel Band Hangers: MSS Type 10.

D. Clamp: MSS Type 4.

E. Double Bolt Clamp: MSS Type 3, including pipe spacers.

2.2 VERTICAL PIPING CLAMPS:

A. General: Except as otherwise indicated, provide factory fabricated vertical piping clamps of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection as determined by the installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size clamps properly for piping, including insulation (if any).

B. Two Bolt Riser Clamp: MSS Type 8.

2.3 HANGER ROD ATTACHMENTS:

A. General: Except as otherwise indicated, provide factory fabricated hanger rod attachments of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by installer for installation requirements, and comply with MSS AP-69 and the manufacturer's published product information. Size attachments properly for piping, including insulation (if any).

B. Turnbuckles: MSS Type 13.

C. Weldless Eye Nut: MSS Type 17.

D. Malleable Eye Socket: MSS Type 16.

E. Clevises: MSS Type 14.

2.4 BUILDING ATTACHMENTS:

A. General: Except as otherwise indicated, provide factory fabricated building attachments of the MSS type and load rating indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or load rating is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published information. Size units properly for piping loading.

B. Concrete Inserts: MSS Type 18, steel.

C. Top Beam C-Clamps: MSS Type 19.

D. C-Clamps: MSS Type 23, steel

E. Top I-Beam Clamp: MSS Type 25.

F. Side Beam Clamp: MSS Type 20.

G. Beam Clamp/Eye Nut: MSS Type 28.

H. Wide Flange Beam Clamp/Eye Nut: MSS Type 29.

I. Beam Clamp/Extension Piece: MSS Type 30.

2.5 SADDLES AND SHIELDS:

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

B. Protection Saddles: MSS Type 39.

C. Protection Shields: MSS Type 40.

D. Wood Insulation Saddle: Provide products manufactured by Elcen Metal Products Company.

2.6 MISCELLANEOUS MATERIALS:

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

PART 3 - EXECUTION

3.1 PREPARATION:

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

3.2 INSTALLATION OF BUILDING ATTACHMENTS:

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

3.3 INSTALLATION OF HANGERS AND SUPPORTS:

A. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire of perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.

3.4 PROVISIONS FOR MOVEMENT:

A. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.

B. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

1. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

C. Insulated Piping: Comply with the following installation requirements:

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
2. Shields: Where low compressive strength insulation of vapor barriers are indicated on cold water piping, install coated protective shields.
3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.5 HYDRONIC PIPING

A. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP 89.

B. Hangers for Pipe Sizes 1/2 to 1-1/2". Malleable iron adjustable swivel, split ring.

C. Hangers for Cold Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.

D. Hangers for Hot Pipe Sizes 2 to 4". Carbon steel, adjustable, clevis.

E. Hangers for Hot Pipe Sizes 6" and Over: Adjustable steel yoke, cast iron roll, double hanger.

F. Multiple or Trapeze Hangers. Steel channels with welded spacers and hanger rods.

G. Multiple or Trapeze Hangers for Hot Pipe Sizes 6" and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

H. Wall Support for Pipe Sizes to 3". Cast iron hook.

I. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.

J. Wall Support for Hot Pipe Sizes 6" and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

K. Vertical Support: Steel riser clamp.

L. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

M. Floor Support for Hot Pipe Sizes to 4": Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

N. Floor Support for Hot Pipe Sizes 6" and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

O. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

3.6 ADJUSTMENT OF HANGERS AND SUPPORTS:

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

END OF SECTION 232117

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Base mounted pumps.

1.2 RELATED SECTIONS

A. Section 23 21 13 - Hydronic Piping.

B. Section 23 21 14 - Hydronic Specialties.

C. Section 23 0549 - Vibration Isolation for HVAC Piping and Equipment.

D. Section 23 0513 - Common Motor Requirements.

1.3 REFERENCES

A. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

B. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010).

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

D. UL 778 - Standard for Motor-Operated Water Pumps; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 PERFORMANCE REQUIREMENTS

A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

D. Millwright's Certificate: Certify that base mounted pumps have been aligned.

E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

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

1. See Division 1 - Product Requirements, for additional provisions.
2. Extra Pump Seals: One set for each type and size of pump.

1.6 WARRANTIES:

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

B. Provide 1 year parts and labor warranty.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

B. Alignment: Base mounted pumps shall be aligned by qualified millwright.

1.8 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by UL 778 as suitable for the purpose specified and indicated.

1.9 EXTRA MATERIALS

A. See Division 1 - Product Requirements, for additional provisions.

B. Provide one set of mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Armstrong Pumps Inc.

B. ITT Bell & Gossett.

C. Taco.

2.2 HVAC PUMPS - GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

2.3 BASE MOUNTED PUMPS

A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.

B. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

C. Impeller: Bronze, fully enclosed, keyed to shaft.

D. Bearings: Permanently lubricated roller or ball bearings.

E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

E. Provide air cock and drain connection on horizontal pump casings.

F. Provide drains for bases and seals, piped to and discharging into floor drains.

G. Check, align, and certify alignment of base mounted pumps prior to start-up.

H. Lubricate pumps before start-up.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Filter-driers.

G. Flexible connections.

1.2 RELATED REQUIREMENTS

A. Section 230719 - HVAC Piping Insulation.

B. Section 230993 - Sequence of Operations for HVAC Controls.

1.3 REFERENCE STANDARDS

A. AHRI 710 - Performance Rating of Liquid-Line Driers; Air-Conditioning, Heating, and Refrigeration Institute; 2009.

B. AHRI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Driers; Air-Conditioning, Heating, and Refrigeration Institute; 2005.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE Std 15).

D. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.

E. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2013.

F. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.

G. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2010.

H. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2011 (ANSI/ASME B31.9).

I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.

J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2013.

K. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.

L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

1.4 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

C. Liquid Indicators:

1. Use line size liquid indicators in main liquid line leaving condenser.

D. Filter-Driers:

1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
2. Use replaceable core liquid-line filter-driers in systems utilizing receivers.

E. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports: Indicate results of leak test, acid test.

F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

G. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

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

1. Extra Filter-Dryer Cartridges: One of each type and size.
2. Refrigeration Oil Test Kits: One, each containing everything required to conduct one test.

1.6 QUALITY ASSURANCE

A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.

1.7 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn .

1. Fittings: ASME B16.22 wrought copper.
2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.

B. Pipe Supports and Anchors:

1. Provide hangers and supports that comply with MSS SP-58.
   a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
5. Vertical Support: Steel riser clamp.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
9. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
    a. Bases: High density polypropylene.
    b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
    c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
    d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
    e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
    f. Manufacturers:
        1) PHP Systems/Design; PHP Pipe Supports: www.phpsd.com.

2.2 REFRIGERANT

A. Refrigerant: R-134a & R-410a as defined in ASHRAE Std 34.

2.3 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:

1. Henry Technologies: www.henrytech.com.
2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
3. Sporlan Valve Company: www.sporlan.com.

B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.4 VALVES

A. Manufacturers:

1. Hansen Technologies Corporation: www.hantech.com.
2. Henry Technologies: www.henrytech.com.
3. Flomatic Valves: www.flomatic.com.

B. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.5 FILTER-DRIERS

A. Performance:

1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
3. Design Working Pressure: 350 psi, minimum.

B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.

1. Replaceable Core Type: Steel shell with removable cap.
2. Connections: As specified for applicable pipe type.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

E. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Flood piping system with nitrogen when brazing.

H. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

I. Insulate piping; refer to Section and Section 23 07 16.

J. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

K. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

L. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

M. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.

1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.

END OF SECTION 232300

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cleaning of piping systems.

B. Chemical feeder equipment.

C. Chemical treatment.

1.2 RELATED SECTIONS

A. Section 23 21 13 - Hydronic Piping.

B. Section 23 21 14 - Hydronic Specialties.

1.3 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.

C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

D. Certificate: Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

E. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

F. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.

B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion. Include monthly service visits and all chemicals

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

C. Provide laboratory and technical assistance services during this maintenance period.

D. Include two-hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at startup of systems.

E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.7 MAINTENANCE MATERIALS

A. See Division 1 - Product Requirements, for additional provisions.

B. Supply sufficient chemicals for treatment and testing during warranty and service period.

C. Provide chemicals for additional 1-year from warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. ChemAqua

B. Proasys

C. ARC

D. Guardian

2.2 MATERIALS

A. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite.

B. Closed System Treatment (Water):

1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.
4. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite.

2.3 BY-PASS (POT) FILTER/FEEDER

A. 5.0 gallon with quick opening cap and 20 micron and 5 micron filter bags. Provide 20 of each type of filter bag for the Owner’s use.

2.4 GLYCOL FEEDER

A. Furnish and install a packaged, automatic glycol actuation make up unit model (GMU as manufactured by ITT Bell & Gossett or approved equal). The package shall consist of a base, polyethylene reservoir with removable lid, visible expansion tank, discharge pressure gage, motor contactor and control circuit in a NEMA 4 panel, and necessary interconnecting piping. Green light shall indicate power supplied to unit. Pump shall start based on falling pressure. System shall require a 115/1/60 single power connection and a 3/4" NPT system piping connection. GMU shall provide 5 GPM and maintain a fill pressure of 30 PSI. Unit includes low level cutout, with red indicator light and 110V contact for alarm indication, to stop the pump during low level condition.

2.5 TEST EQUIPMENT

A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.

B. Provide the following test kits:

1. Alkalinity titration test kit.
2. Chloride titration test kit.
3. Sulphite titration test kit.

4. Total hardness titration test kit.
5. Low phosphate test kit.
6. Conductivity bridge, range 0 - 10,000 micro-ohms.
7. Creosol red pH slide complete with reagent.
8. Portable electronic conductivity meter.
9. High nitrite test kit.

PART 3 - EXECUTION

3.1 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

3.2 CLEANING SEQUENCE

A. Concentration:

1. As recommended by CLEANER manufacturer.

B. Hot Water Heating Systems:

1. Add cleaner, apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.
5. Test water sample to verify cleaner is removed.

C. Chilled Water Systems:

1. Add cleaner, circulate for 48 hours, then drain systems as quickly as possible.
2. Refill with clean water, circulate for 24 hours, then drain.
3. Refill with clean water and repeat until system cleaner is removed.
4. Test water sample to verify cleaner is removed.

D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.

E. Flush open systems with clean water for one hour minimum. Drain completely and refill.

F. Remove, clean, and replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

H. System shall flushed, treated, and tested in accordance with the phasing. Multiple phased treatments will be required.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

A. Provide one bypass filter/feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens. Provide one for each bypass filter/feeder location.

3.5 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.

1. Provide minimum of two hours of instruction for two people.
2. Have operation and maintenance data prepared and available for review during training.
3. Conduct training using actual equipment after treated system has been put into full operation.

3.6 MAINTENANCE

A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.

B. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.

C. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

D. Provide laboratory and technical assistance services during this maintenance period.

E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION 232500

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

B. Casing and plenums.

C. Kitchen hood ductwork.

D. Flexible Ductwork

E. Duct cleaning.

1.2 RELATED REQUIREMENTS

A. Section 230713 - Duct Insulation: External insulation and duct liner.

B. Section 233300 - Air Duct Accessories.

C. Section 233600 - Air Terminal Units.

D. Section 233700 - Air Outlets and Inlets.

E. Section 230593 - Testing, Adjusting, and Balancing for HVAC.

1.3 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.

B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications; 2012.

C. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2013.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.

E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2013.

F. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy With Improved Formability, and Ultra-High Strength; 2013.

G. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

H. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.

J. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.

K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.

L. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2011.

M. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.

N. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.

O. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication & Installation Guidelines; 2001.

P. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for 1 inch pressure class and higher systems.

D. Samples: Submit two samples of typical shop fabricated duct fittings.

E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.6 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A standards.

1.7 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

A. All Ducts: Galvanized steel, unless otherwise indicated.

B. Low Pressure Supply (Heating Systems): 2 inch w.g. pressure class, galvanized steel.

C. Low Pressure Supply (System with Cooling Coils): 2 inch w.g. pressure class, galvanized steel.

D. Medium and High Pressure Supply: 4 inch w.g. pressure class, galvanized steel. Use for VAV systems between the unit and the VAV boxes.

E. Outside Air Intake: 2 inch w.g. pressure class, galvanized steel.

F Combustion Air: CPVC.

G. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, lined galvanized.

H. Dishwasher Exhaust: 2 inch w.g. pressure class, stainless steel.

1. Construct of 18 gage stainless steel using continuous external welded joints in rectangular sections.

I. Grease Exhaust: 2 inch w.g. pressure class, stainless steel.

1. Construction:

a. Construct of 18 gage stainless steel using continuous external welded joints in rectangular sections.
b. Where ducts are not self-draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.

2. Access Doors:

a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.

2.2 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.

C. Stainless Steel for Ducts: ASTM A 240/A 240M, Type 304.

D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
2. VOC Content: Not more than 250 g/L, excluding water.
3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
4. For Use With Flexible Ducts: UL labeled.

E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

F. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

2.3 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.

D. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.

2.4 MANUFACTURED DUCTWORK AND FITTINGS

A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with 18-gauge galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.

1. Manufacture in accordance with SMACNA HVAC Duct Construction Standards.
2. Insulation:

a. Thickness: 1.5 inch
b. Material: Fiberglass.

B. Double Wall Rectangular Ducts: Rectangular double wall ducts shall have a solid 18-gauge galvanized steel outer shell and a perforated inner liner, separated with a 1.5" thick fiberglass insulating layer. Fittings shall have solid inner walls.

C. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.

1. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -20 degrees F to 210 degrees F.
4. Minimum R-value: R-6

D. PVC Coated Steel Ducts: UL 181, Class 1, galvanized steel duct coated with 4 mil (0.1 mm) polyvinyl chloride plastic on both sides.

2.5 KITCHEN HOOD EXHAUST DUCTWORK

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, SMACNA Kitchen Ventilation Systems and Food Service Equipment Fabrication & Installation Guidelines and NFPA 96 and the International Mechanical Code.

2.6 CASINGS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards and construct for operating pressures indicated.

B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

G. Use double nuts and lock washers on threaded rod supports.

H. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

I. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

J. Exposed ductwork shall be furnished with a paint-grip finish.

3.2 DUCT LEAKAGE TESTING

A. Perform duct leakage test in accordance with 230593 – HVAC Testing, Adjusting and Balancing. Perform all tests in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Perform leakage test for kitchen grease duct systems, 20% of medium and high-pressure duct systems and 10% of low-pressure duct systems. Leakage testing shall be conducted by the Contractor prior to system balancing.

3.3 CLEANING

A. Ducts shall be installed per SMACNA cleanliness standards, shipped with sealed ends, and protected during construction and installation. Cleaning of new systems shall not be required if these steps are followed. If they are not followed, the HVAC system shall be cleaned using source removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor’s responsibility to select source removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification. Means, methods and materials shall be as described in the NADCA General Specifications for the Cleaning of Commercial HVAC Systems manual, and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC

system or negatively alter the integrity of the system.

B. Exposed ductwork shall have its exterior cleaned (in accordance with the manufacturer's recommended methods) to the satisfaction of the Architect.

END OF SECTION 233100

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air turning devices/extractors.

B. Backdraft dampers.

C. Duct access doors.

D. Duct test holes.

E. Fire dampers.

F. Flexible duct connections.

G. Volume control dampers.

1.2 RELATED SECTIONS

A. Section 23 31 00 - HVAC Ducts and Casings.

B. Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.

1.3 REFERENCES

A. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 2012.

B. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

C. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

D. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

E. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for shop fabricated assemblies including volume control dampers and duct access doors.

C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.

D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and smoke dampers..

1.5 PROJECT RECORD DOCUMENTS

A. Record actual locations of access doors and test holes.

1.6 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

1.8 EXTRA MATERIALS

A. See Division 1 - Product Requirements, for additional provisions.

B. Provide two of each size and type of fusible link.

PART 2 - PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:

1. Ruskin Company: www.ruskin.com.
2. Titus: www.titus-hvac.com.

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

2.2 BACKDRAFT DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc: www.louvers-dampers.com.
2. Nailor Industries Inc: www.nailor.com.
3. Ruskin Company: www.ruskin.com.

B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 DUCT ACCESS DOORS

A. Manufacturers:

1. Ruskin Company: www.ruskin.com.
2. Approved Equal.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.

1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.

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

2.4 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FIRE DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc: www.louvers-dampers.com.
2. Nailor Industries Inc: www.nailor.com.
3. Ruskin Company: www.ruskin.com.

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

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

D. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

F. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

H. All dampers shall be dynamic type.

2.6 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

B. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
   a. Net Fabric Width: Approximately 2 inches wide.
2. Metal: 3 inches wide, 24 gage thick galvanized steel.

2.7 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc: www.louvers-dampers.com.
2. Nailor Industries Inc: www.nailor.com.
3. Ruskin Company: www.ruskin.com.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

C. Splitter Dampers:

1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .

D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

G. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards. Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Demonstrate re-setting of fire dampers to Owner's representative.

G. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

H. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

I. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

J. Use splitter dampers only where indicated.

K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

L. Provide turning vanes, Air Turning Devices, at all elbows greater than 45 degrees and all radiused elbows.

1. Provide Blades: 2" galvanized steel for up to and including 18" ducts.
2. Blades: 4 1/2" galvanized for ducts over 18"
3. Construction: Double wall blade.
4. Types: Gang operated blades with removable hex key.
5. Types: Gang operated blades with removable lever.
6. Types: Fixed blades for 90 degree elbows.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1- GENERAL

1.1 SECTION INCLUDES

A. Roof exhausters.

B. Ceiling-mounted fans.

C. Kitchen hood up-blast roof exhausters.

1.2 RELATED SECTIONS

A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

B. Section 23 33 00 - Air Duct Accessories.

1.3 REFERENCES

A. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.

B. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).

C. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; http://www.amca.org/certified/search/company.aspx.

D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.

E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 1990.

F. IMC 2015 - International Mechanical Code.

G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2011.

J. UL 705 - Power Ventilators; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

K. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

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

1. Extra Fan Belts: One set for each individual fan.

1.5 QUALITY ASSURANCE

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

B. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96 and the International Mechanical Code.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Permanent ventilators may not be used for ventilation during construction.

1.7 EXTRA MATERIALS

A. Supply two sets of belts for each belt-driven fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Greenheck.

B. Loren Cook Company.

C. PennBarry.

D. CaptiveAire.

2.2 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.

B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.

D. Fabrication: Conform to AMCA 99.

E. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

G. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96 and the International Mechanical Code.

2.3 ROOF EXHAUSTERS

A. Product Requirements:

1. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
2. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
3. Fabrication: Conform to AMCA 99.
4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

C. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

D. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor .

F. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.

G. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

H. Kitchen hood exhaust fans shall be upblast type complying with NFPA 96 and shall have hinged base plate and grease collection system.

2.4 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

A. Belt Drive Fan:

1. Fan Wheel:
   a. Type: Non-overloading, backward inclined centrifugal.
   b. Material: Aluminum.
2. Statically and dynamically balanced.
3. Motors:
   a. Open drip-proof (ODP).
   b. Heavy duty ball bearing type.
   c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
   d. Fully accessible for maintenance.
4. Housing:
   a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
   b. Rigid internal support structure.
   c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
   d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
   e. Provide breather tube for fresh air motor cooling and wiring.

B. Shafts and Bearings:

1. Fan Shaft:
   a. Ground and polished steel with anti-corrosive coating.
   b. First critical speed at least 25 percent over maximum cataloged operating speed.
2. Bearings:
   a. Permanently sealed or pillow block type.
   b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
   c. 100 percent factory tested.

C. Drive Assembly:

1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

D. Disconnect Switches:

1. Factory mounted and wired.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
3. Finish for Painted Steel Enclosures: Provide manufacturer's standard unless otherwise indicated.
4. Positive electrical shutoff.

5. Wired from fan motor to junction box installed within motor compartment.

E. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Accessories:

1. Birdscreen:
   a. Provide galvanized steel construction.
   b. Protects fan discharge.
2. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
3. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
4. Grease Trap:
   a. Aluminum.
   b. Includes drain connection.
   c. Collects grease residue.
5. Hinge Kit:
   a. Aluminum hinges.
   b. Hinges and restraint cables mounted to base (sleeve).
   c. Allows fan to tilt away for access to wheel and ductwork for inspection and cleaning.
6. Heat Baffle: Prevents heat from radiating into motor compartment.
7. Tie-down Points: Four brackets located on windband secures fan in heavy wind applications.

2.5 DIRECT DRIVE STANDARD CEILING MOUNTED CENTRIFUGAL EXHAUST FANS

A. General Description:

1. Base fan performance at standard conditions (density 0.075 Lb/ft3)
2. Ceiling mounted applications
3. Performance capabilities up to 52 cubic feet per minute (cfm) and static pressure to 0.625 inches of water gauge
4. Maximum operating temperatures is 130 Fahrenheit (54.4 Celsius)
5. Sound levels as low as 2.9 AMCA sones
6. UL/cUL listed for above bathtub exhaust
7. Fans are UL/cUL listed 507 - Electric Fans
8. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number

B. Wheel:

1. Forward curved centrifugal wheel
2. Constructed of high strength polymer
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.

C. Motors:

1. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets
2. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase
3. Accessible for maintenance
4. Compatible for use with speed controls
5. Thermal overload protection

D. Housing:

1. Constructed of heavy gauge galvanized steel
2. Profile as low as 3 5/8 inches

E. Plastic Backdraft Damper:

1. Prevents air from entering back into the building when fan is off
2. Eliminates rattling or unwanted backdrafts

F. Outlet:

1. Round outlet shall accept a three inch diameter duct
2. Plastic duct collar shall be a tapered sleeve for ease of connection

G. Grille:

1. Constructed of non-yellowing high strength polymer
2. Attached to the housing with torsion springs

H. Mounting Brackets:

1. Fully adjustable for multiple installation conditions

I. Accessories:

1. Provide disconnect switch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counter-flash duct to roof opening.

D. Provide sheaves required for final air balance.

E. Install backdraft dampers on inlet to roof and wall exhausters, except kitchen hood fans.

F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Variable volume terminal units.

B. Integral heating coils.

1.2 RELATED REQUIREMENTS

A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

B. Section 23 21 13 - Hydronic Piping: Connections to heating coils.

C. Section 23 21 14 - Hydronic Specialties: Connections to heating coils.

D. Section 23 31 00 - HVAC Ducts and Casings.

E. Section 23 37 00 - Air Outlets and Inlets.

1.3 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association; 2012.

B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.

1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.

D. Manufacturer's Installation Instructions: Indicate support and hanging details, and service clearances required.

E. Project Record Documents: Record actual locations of units.

F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

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

B. Provide two year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Johnson Controls Inc. (Basis of Design)

B. Trane

C. Daikin

2.2 MANUFACTURED UNITS

A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electronic variable volume controls,, hot water heating coils.

B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.3 SINGLE DUCT VARIABLE VOLUME UNITS

A. Basic Assembly:

1. Casings: Minimum 22 gage galvanized steel.
2. Lining: Minimum 1/2 inch thick neoprene or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with mylar film.
3. Plenum Air Inlets: Round stub connections for duct attachment.
4. Plenum Air Outlets: S slip and drive connections.

B. Basic Unit:

1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.

C. Attenuator Section: Line attenuator sections with 2 inch thick insulation.

D. Hot Water Heating Coil:

1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.

E. Automatic Damper Operator:

1. Electric Actuator: 24 volt with high limit.

F. Provide factory mounting and wiring of controls. Controls shall be provided by the ATC Contractor.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Support units individually from structure. Do not support from adjacent ductwork.

C. Connect to ductwork in accordance with Section 23 31 00.

D. Verify that electric power is available and of the correct characteristics.

3.2 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow.

END OF SECTION 233600

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

C. Louvers.

D. Vents

E. Roof hoods.

1.2 REFERENCES

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2012.

B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute; 2008.

C. ASHRAE Std 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; 2006.

D. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

1.3 SUBMITTALS

A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

B. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.

B. Test and rate louver performance in accordance with AMCA 500-L.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Titus

B. Price Industries

C. Metalaire

D. Kreuger.

2.2 RECTANGULAR CEILING DIFFUSERS

A. Type: Square and rectangular, multi-louvered diffuser to discharge air in pattern as indicated on the drawings.

B. Frame: Lay-in mount type.

C. Color: As shown on drawings.

D. Fabrication: Steel with baked enamel finish.

2.3 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.

B. Frame: 1-1/4 inch margin with countersunk screw mounting.

C. Color: As shown on the drawings.

D. Fabrication: Steel with 20 gage minimum frames and 13 gauge minimum steel blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish, color to be selected.

E. Fabrication: Steel with 20 gage minimum frames and 13 gauge minimum steel blades.

F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

G. Provide welded in place blades, securely fastened to be immobile.

2.4 CEILING SLOT DIFFUSERS

A. Type: Continuous slots as scheduled on drawings with vanes for left, right , or vertical discharge.

B. Color: As shown on the drawings.

C. Fabrication: Aluminum extrusions with factory baked enamel finish .

D. Frame: 1-1/4 inch margin with concealed mounting and gasket, mitered end border.

E. Plenum: Integral, galvanized steel, insulated.

2.5 WALL SUPPLY REGISTERS/GRILLES

A. Type: As scheduled on drawings.

B. Color: As shown on the drawings.

C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish, color to be selected.

D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.6 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.

B. Fabrication: Steel frames and blades, with factory baked enamel finish.

C. Color: As shown on the drawings.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.7 LOUVERS

A. Manufacturers:

1. Ruskin Model ELF6375DXH
2. Greenheck Model ESD-603

B. Type: 6 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake. Louvers shall be 0.125" thick extruded aluminum blades and mullions. Provide continuous blade reinforcing and concealed structural mullions. Finish shall be in a custom Kynar color selected by the Architect. Provide vertical mullions as shown on the architectural elevations.

2.8 VENTS

A. Dryer/Kiln Exhaust Termination: Provide Tjernlund Products, Inc. Model VH1-3 sidewall vent hood or equal.

2.9 ROOF HOODS

A. General Description:

1. Ventilator is low silhouette for intake/relief applications.

B. Hood and Base:

1. Material Type: Aluminum.
2. Hood Constructed of precision formed, arched panels with interlocking seams.
3. Vertical end panels are fully locked into hood end panels.
4. Base height is standard of 5 inches.
5. Curb cap is six inches larger then throat size.
6. Curb cap has pre-punched mounting holes for installation.

C. Birdscreen:

1. Constructed of ½ inch Aluminum mesh.
2. Mounted horizontally across the intake area of the hood.

D. Hood Support:

1. Constructed of galvanized steel and fastened so the hood can either be removed completely from the base or hinged open.

E. Options/Accessories:

1. Roof Curbs:
   a. Type: Welded, straight sided curb.
   b. Material: Aluminum.
   c. Insulation thickness: 2 inches.
   d. Height: 18 inches.
2. Dampers:
   a. Type: As noted on the drawings.
   b. Prevents outside air from entering back into the building when fan is off
   c. Balanced for minimal resistance to flow
   d. Galvanized frames with pre-punched mounting holes
3. Insect Screen:
   a. Constructed of fine mesh aluminum
   b. Fitted to the top of the throat and prevents entry of insects

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location and sizes of outlets and inlets and make necessary adjustments in position and/or size to conform with architectural features, symmetry, lighting arrangement, and ceiling grid.

C. Ceiling grilles and registers shall fit in tiles without infringing on the ceiling grid. Any discrepancies shall be reported prior to ordering the inlet/outlet.

D. Install diffusers to ductwork with air tight connection.

E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 90 00.

END OF SECTION 233700

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

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manufactured breechings.

B. Manufactured double wall chimneys for fuel fired equipment.

1.2 RELATED SECTIONS

A. Section 23 0716 - HVAC Equipment Insulation.

1.3 REFERENCES

A. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.

B. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; National Fire Protection Association; 2010.

C. UL 441 - Standard for Gas Vents; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 DEFINITIONS

A. Breeching: Vent Connector.

B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

C. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

D. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.5 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations .

D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

E. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.

F. Manufacturer shall provide pressure drop calculations for each stack run and verify with heating equipment manufacturer stack pressure drop is within manufacturer's recommended limits.

1.6 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of documented experience and approved by manufacturer.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for installation of natural gas burning appliances and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Metal-Fab, Inc.

B. Heat Fab.

2.2 MANUFACTURED BREECHINGS

A. Assembly to be UL listed for use with building equipment in compliance with NFPA 211.

B. Fabricate with 1 inch minimum air space between walls and construct inner liner of AL-49C stainless steel and outer jacket of 304 stainless steel.

C. Design, fabricate, and install gas-tight preventing products of combustion leaking into the building.

1. Securely connect inner joints and seal with factory supplied overlapping V-bands and appropriate sealant in accordance with manufacturer's instructions.
2. System design to compensate for all flue gas induced thermal expansion.

2.3 DOUBLE WALL METAL STACKS

A. Provide double wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.

B. Fabricate with 1 inch minimum air space between walls and construct inner liner of AL29-4C stainless steel and outer jacket of 304 stainless steel.

1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.

C. Accessories, UL labeled:

1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
2. Exit Cone: Consists of inner cone, and outer jacket, to increase stack exit velocity 1.5 times.
3. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

D. Provide pressure rated double wall metal stacks, tested to UL 103 and UL listed, for use with boilers and domestic hot water heaters, in compliance with NFPA 211.

E. For gas fired condensing boilers and domestic hot water heaters provide positive pressure AL 29-4C vent. Refer to drawing details for locations of single and double wall vent and installation requirements.

F. Manufacturers:

1. Heat Fab: Model Saf-T Vent SC.
2. Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 54.

C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards for equivalent duct support configuration and size.

E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

F. Level and plumb chimney and stacks.

G. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

3.2 SCHEDULES

A. Breechings, Chimneys and Stacks

1. Boilers: Double wall pressure stack type AL 29-4C.

END OF SECTION 235100

SECTION 235233 - HIGH EFFICIENCY CONDENSING BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Boilers.

B. Boiler trim.

C. Hot water connections.

D. Fuel connection.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Aerco International Benchmark Series Boiler.

B. RBI Flexcore CK Series Boiler.

C. Raypak Xvers Boiler.

2.2 REGULATORY REQUIREMENTS

A. Boiler shall be; UL Listed, CSD-1 approved, ASME coded and stamped, and incorporate a gas train designed in accordance with IRI.

B. The boiler manufacturer must publish known part load value efficiencies; the thermal efficiency must increase as the firing rate decreases. The accuracy of these published efficiencies must be reviewed & confirmed by Underwriter's Laboratories, Inc.

C. Boiler control panel shall incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display, on individual field replaceable circuit boards mounted within a single housing.

D. Boiler shall have an ASME approved relief valve setting of 50 psig.

2.3 CONSTRUCTION

A. Boiler modules shall be natural gas fired, condensing fire tube design with a modulating forced draft power burner and positive pressure vent discharge.

B. Modulating Air/Fuel Valve and Burner:

1. The boiler burner shall be capable of a 15 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves.
2. The burner shall produce <30ppm of NOx corrected to 3% excess oxygen.

3. The burner shall be metal fiber mesh covering a stainless steel body, with spark ignition and flame rectification.
4. All burner material exposed to the combustion zone shall be of stainless steel construction.
5. There shall be no moving parts within the burner itself.
6. A modulating air/fuel valve shall meter the air and natural gas input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A cast aluminum venturi with integral mixer shall be utilized to ensure the optimum pre-mix of air & fuel between the air/fuel valve and the burner,

C. Pressure Vessel/Heat Exchanger:

1. The boiler shall be capable of handling return water temperatures down to 40 F without any failure due to thermal shock or fireside condensation. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig.
2. The pressure vessel shall have a maximum water volume of 49 gallons. The boiler water pressure drop shall not exceed 5.5 psig at 258gpm.
3. The boiler water connections shall be 4” flanged 150 lb. ANSI rated. The pressure vessel is constructed of SA53 carbon steel, with a 0.25” thick wall and 0.25 in. thick upper head.
4. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code.
5. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.
6. The heat exchanger shall be constructed of 316L stainless steel fire tubes and tube sheets with a one-pass combustion gas flow design.
7. The fire tubes shall be 5/8” OD with no less than 0.065” wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.313” thick.
8. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig.
9. Access to the tubesheets and heat exchanger is available by burner and exhaust manifold removal. Minimum access opening shall be no less than 10 in. diameter.

D. Exhaust Manifold:

1. The exhaust manifold shall be of corrosion resistant cast aluminum with an 8“diameter flue connection. The exhaust manifold shall have a gravity drain for the elimination of the condensation with collecting reservoir.

E. Boiler Controls:

1. The boiler control system shall be segregated into three components: Control Panel, Power Box, and Input/Output Connection Box. The entire system shall be Underwriters Laboratories Recognized.

2. The control panel shall consist of 6 individual circuit boards utilizing state-of-the-art surface-mount technology, in a single enclosure. These circuit boards shall be defined as follows: display board incorporating LED display to read temperature, and a VFD display module for all message annunciation; CPU board which houses all control functions; electric low water cutoff board with test and manual reset functions; power supply board; ignition /stepper board incorporating flame safeguard control; and connector board. Each board shall be individually field replaceable. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor. The control panel hardware shall support both RS-232 and RS-485 remote communications. The controls shall annunciate boiler & sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of 8 separate status messages and 34 separate fault messages.
3. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features are called: Setpoint High Limit, Setpoint Low Limit, and Failsafe Mode. Setpoint High Limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor.

F. Network Direct Drive:

1. Boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler without header temperature swings.
2. The boiler will operate to vary the boiler firing rate as an external communication utilizing the MODBUS protocol is supplied via the RS-485 port. Unit shall operate with an Inverse Efficiency Curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at minimum firing input. The boiler shall have LCD display for monitoring of all sensors and interlocks.

G. Controls Interoperability

1. The control panel shall utilize the MODBUS or Lon Works open protocol to interface with third party building automation systems. When the Building Automation System (BAS) does not have MODBUS protocol capability and interoperability is required, the manufacturer shall provide a protonode to act as a Gateway interface between the BAS and the boiler control panel.

H. Installation

1. All aspects of installation of Boiler Plant shall be in strict accordance with manufacturer's instructions. The vent system must conform to all manufacturer's recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure.
2. Boiler shall have individually isolating shutoff valves for service and maintenance.

I. Warranty

1. The pressure vessel/heat exchanger of the boiler shall carry a non-prorated 7 year warranty against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship. A Warranty Certificate must be issued to the owner from the manufacturer and a copy of warranty must be submitted for engineer's approval.

J. Field Services

1. Contractor shall provide the services of a local factory authorized representative to supervise all phases of equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the engineer with operation and maintenance instructions.

END OF SECTION 235233

SECTION 236426 – PACKAGED WATER CHILLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Design, performance criteria, refrigerants, controls, and installation requirements for air-cooled scroll compressor chillers.

1.2 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

B. Section 23 0553 - Identification for HVAC Piping and Equipment.

C. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.

D. Section 23 0923 - Automatic Temperature Controls.

E. Section 23 0992 - HVAC Control Sequence.

F. Section 23 2113 - Hydronic Piping.

G. Section 23 2114 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

A. AHRI 550/590 - Standard for Performance Rating of Water-Chilling Packages Using the Vapor Compression Cycle; Air-Conditioning, Heating, and Refrigeration Institute; 2011.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc; 2010 (ANSI/ASHRAE Std 15).

C. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc; 2010, Including All Addenda, (ANSI/ASHRAE/IESNA Std 90).

D. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2013.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

F. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

G. UL 1995 - Heating and Cooling Equipment; Underwriters Laboratories Inc; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

1.5 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

D. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.

E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Division 1 - Product Requirements, for additional provisions.
2. Extra Refrigerant: One container.
3. Extra Lubricating Oil: One container.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Conform to manufacturer's written installation instructions for rigging, unloading, and transporting units.

B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.8 WARRANTY

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

B. Manufacturer's Warranty: The manufacturer shall provide a warranty for two years, covering all portions of the units. Defective parts shall be repaired or replaced during the warranty period at no charge to the Owner. The warranty period shall commence at the project's substantial completion. The compressors and heat exchange circuit shall be warranted for five years. The warranties shall include parts and labor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. JCI (Basis of Design).

B. Trane.

C. Daikin.

2.2 AIR COOLED CHILLER

A. UNIT DESCRIPTION

1. Provide and install as shown on the plans factory-assembled, factory-charged air-cooled scroll compressor packaged chillers in the quantity specified. Each chiller shall consist of hermetic tandem scroll compressor sets (total four compressors), brazed plate evaporator, air-cooled condenser section, microprocessor-based control system and all components necessary for controlled unit operation.
2. Chiller shall be functionally tested at the factory to ensure trouble free field operation

B. DESIGN REQUIREMENTS

1. Flow Range: The chiller shall have the ability to support variable flow range down to 40% of nominal design (based on AHRI conditions).
2. Operating Range: The chiller shall have the ability to control leaving chilled fluid temperature from 15F to 65F.
3. General: Provide a complete scroll compressor packaged chiller as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.02 and any local codes in effect.
4. Performance: Refer to the schedule of performance on the drawings. The chiller shall be capable of stable operation to a minimum percentage of full load (without hot gas bypass) of 17%. Performance shall be in accordance with AHRI Standard 550/590.
5. Acoustics: Sound pressure levels for the unit shall not exceed the following specified levels. All manufacturers shall provide the necessary sound treatment (parts and labor) to meet these levels if required. Sound data shall be provided with the quotation. Test shall be in accordance with AHRI Standard 370.

C. CHILLER COMPONENTS

1. Compressor
   a. The compressors shall be sealed hermetic, scroll type with crankcase oil heater and suction strainer. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads. The compressors shall be

equipped with an internal module providing compressor protection and communication capability.

2. Evaporator
   a. The evaporator shall be a compact, high efficiency, dual circuit, brazed plate-to-plate type heat exchanger consisting of parallel stainless steel plates.
   b. The evaporator shall be protected with an external, electric resistance heater plate and insulated with 3/4" (19mm) thick closed-cell polyurethane insulation. This combination shall provide freeze protection down to -20°F (-29°C) ambient air temperature.
   c. The water-side working pressure shall be a minimum of 653 psig (4502 kPa). Evaporators shall be designed and constructed according to, and listed by Underwriters Laboratories (UL).
3. Condenser
   a. Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct-drive fan motors. The fans shall be equipped with a heavy-gauge vinyl-coated fan guard. Fan motors shall be TEAO type with permanently lubricated ball bearings, inherent overload protection, three-phase, direct-drive, 1140 rpm. Each fan section shall be partitioned to avoid cross circulation.
   b. Coil shall be microchannel design and shall have a series of flat tubes containing multiple, parallel flow microchannels layered between the refrigerant manifolds. Tubes shall be 9153 aluminum alloy. Tubes made of 3102 alloy or other alloys of lower corrosion resistance shall not be accepted. Coils shall consist of a two-pass arrangement. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils shall withstand 1000+ hour acidified synthetic sea water fog (SWAAT) test (ASTM G85-02) at 120°F (49°C) with 0% fin loss and develop no leaks.
4. Refrigerant Circuit
   a. Each of the two refrigerant circuits shall include a replaceable-core refrigerant filter-drier, sight glass with moisture indicator, liquid line solenoid valve (no exceptions), expansion valve, and insulated suction line.
5. Construction
   a. Unit casing and all structural members and rails shall be fabricated of pre-painted or galvanized steel. Painted parts shall be able to meet ASTM B117, 1000-hour salt spray test.
   b. Upper condenser coil section of unit shall have protective, 12 GA, PVC-coated, wire grille guards.
6. Control System
   a. A centrally located weatherproof control panel shall contain the field power connection points, control interlock terminals, and control system. Box shall be designed in accordance with NEMA 3R rating. Power and starting components shall include factory circuit breaker for fan motors and control circuit, individual contactors for each fan motor, solid-state compressor three-phase motor overload protection, inherent fan motor overload protection and two power blocks (one per circuit) for connection to remote, contractor supplied disconnect switches. Hinged access doors shall be lockable. Barrier panels or separate enclosures are required to protect against accidental contact with line voltage when accessing the control system.
   b. Shall include optional multi-point disconnect switches (one per circuit).

7. Unit Controller
   a. An advanced DDC microprocessor unit controller with a 5-line by 22-character liquid crystal display provides the operating and protection functions. The controller shall take preemptive limiting action in case of high discharge pressure or low evaporator pressure. The controller shall contain the following features as a minimum:
   b. The unit shall be protected in two ways: (1) by alarms that shut the unit down and require manual reset to restore unit operation and (2) by limit alarms that reduce unit operation in response to some out-of-limit condition. Shut down alarms shall activate an alarm signal.
   c. Shutdown Alarms
      1) No evaporator water flow (auto-restart)
      2) Sensor failures
      3) Low evaporator pressure
      4) Evaporator freeze protection
      5) High condenser pressure
      6) Outside ambient temperature (auto-restart)
      7) Motor protection system
      8) Phase voltage protection (Optional)
   d. Limit Alarms
      1) Condenser pressure stage down, unloads unit at high discharge pressures.
      2) Low ambient lockout, shuts off unit at low ambient temperatures.
      3) Low evaporator pressure hold, holds stage #1 until pressure rises.
      4) Low evaporator pressure unload, shuts off one compressor.
   e. Unit Enable Section
      1) Enables unit operation from either local keypad, digital input, or BAS
   f. Unit Mode Selection
      1) Selects standard cooling, ice, glycol, or test operation mode
   g. Analog Inputs:
      1) Reset of leaving water temperature, 4-20 mA\
      2) Current Limit
   h. Digital Inputs
      1) Unit off switch
      2) Remote start/stop
      3) Flow switch
      4) Ice mode switch, converts operation and set-points for ice production
      5) Motor protection
   i. Digital Outputs
      1) Shutdown alarm; field wired, activates on an alarm condition, off when alarm is cleared
      2) Evaporator pump; field wired, starts pump when unit is set to start
   j. Condenser fan control - The unit controller shall provide control of condenser fans based on compressor discharge pressure.
   k. Building Automation System (BAS) Interface
      1) Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARK ® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
      2) BACnet MS/TP master (Clause 9)
      3) BACnet IP, (Annex J)
      4) BACnet ISO 8802-3, (Ethernet)

5) LONMARK FTT-10A. The unit controller shall be LONMARK® certified.
6) The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
7) For chillers communicating over a LONMARK network, the corresponding LONMARK eXternal Interface File (XIF) shall be provided with the chiller submittal data.
8) All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

D. ACCESSORIES
1. The following accessories shall be included:
   a. Hot Gas Bypass: allows unit operation to 10 percent of full load. Includes factory-mounted hot gas bypass valve, solenoid valve, and manual shutoff valve for each circuit.
   b. Low Ambient Control: Fan VFD allows unit operation from 32°F down to -10°F (-23.3 C).
   c. High Ambient Control Panel for operation from 105°F up to 125°F ambient temperatures
   d. Phase loss with under/over voltage protection and with LED indication of the fault type to guard against compressor motor burnout.
   e. BAS interface module to provide interface with the BACnet MSTP protocol.
   f. Compressor Sound Reduction - Acoustic reduction blankets shall be factory installed on each compressor.
   g. Spring vibration isolators for field installation
   h. Factory-mounted thermal dispersion type flow switch
   i. Field-mounted, paddle type, chilled water flow switch field wired to the control panel
   j. Wye strainer, to be installed at the evaporator inlet and sized for the design flow rate , with perforation diameter of 0.063" with blowdown valve and Victaulic couplings (factory mounted or field installed)
   k. 115V GFI convenience outlet

E. ACOUSTICAL TREATMENTS
1. The following accessories shall be included:
   a. Acoustical Hushcore blankets for compressors and piping shall be furnished by BRD and installed by this Contractor. Approved equals shall be pre-approved by the engineer.
   b. Acoustical Hushcore Premium OF curtains for a 140’ long portion of the chain link fence enclosure shall be furnished by BRD and installed by this Contractor. Coordinate length and height with dimensions represented on civil plans. Approved equals shall be pre-approved by the engineer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in strict accordance with manufacturer's requirements, shop drawings, and contract documents.

B. Adjust and level chiller in alignment on supports.

C. Coordinate electrical installation with electrical contractor.

D. Coordinate controls with control contractor.

E. Install a field-supplied or optional manufacturer-supplied strainer in the chilled water return line at the evaporator inlet that meets manufacturer perforation size specifications.

3.2 START-UP

A. Provide testing and starting of machine, and instruct the Owner in its proper operation and maintenance.

END OF SECTION 236426

SECTION 237313 – ROOFTOP AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Rooftop Air Handling Units

B. Rooftop Energy Recovery Units

1.2 RELATED REQUIREMENTS

A. Section 230513 - Common Motor Requirements for HVAC Equipment.

B. Section 230549 - Vibration and Seismic Controls for HVAC Piping and Equipment.

C. Section 230719 - HVAC Piping Insulation.

D. Section 233300 - Air Duct Accessories: Flexible duct connections.

1.3 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).

B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).

C. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment; 2011.

D. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; Air-Conditioning, Heating, and Refrigeration Institute; 2001 (R2011).

E. AHRI 430 - Standard for Central-Station Air-Handling Units; Air-Conditioning, Heating, and Refrigeration Institute; 2009.

F. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 2010.

G. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).

H. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.

I. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc; 2007.

J. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2012.

K. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2012.

L. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2012.

M. ASHRAE Std 62.1 - Ventilation For Acceptable Indoor Air Quality; 2012.

N. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2010, Including All Addenda (ANSI/ASHRAE/IESNA Std 90).

O. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating; 2011.

P. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

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

R. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2012.

S. SMACNA (DCS) - HVAC Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

T. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; current edition.

U. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data:

1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Include installation instructions.

E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

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

1. See Division 1 - Product Requirements, for additional provisions.
2. Extra Fan Belts: One set for each unit.

1.5 QUALITY ASSURANCE

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

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Johnson Controls Inc. (Basis of Design)

B. Trane.

C. Daikin.

D. Valent.

2.2 GENERAL DESCRIPTION

A. Configuration: Fabricate as detailed on drawings.

B. Performance: Conform to AHRI 430. See schedules on prints. (NOTE: above does not apply to fan array)

C. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

2.4 UNIT CONSTRUCTION

A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.

B. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.

1. The inner liner shall be constructed of G90 galvanized steel.
2. The outer panel shall be constructed of G60 painted galvanized steel.
3. The floor plate shall be constructed as specified for the inner liner.
4. Unit will be furnished with solid inner liners.

C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.

D. The casing leakage rate shall not exceed .5 cfm per square foot of cabinet area at 5 inches of positive static pressure or 6 inches of negative static pressure (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure).

E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.

F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.

G. The unit base shall be provided by this manufacturer.

H. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3’’ above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2’’ thickness of insulation under drain pan.

I. Rooftop units shall have exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

J. Rooftop units shall have a unit base that overhangs the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

K. An insulated pipe chase shall be provided and the unit's roof curb shall extend to house the pipe chase. The Roofcap over vestibule shall be a continuous single piece covering both the coil section and the vestibule. Roofcap seams between coil section and vestibule are not allowed.

2.5 FAN ASSEMBLIES

A. Provide ECM, motorized impeller fan(s). Fan assembly shall include fan, fan base, and a motor and shall be dynamically balanced by the fan manufacturer.

1. Motor control panel shall come equipped with a fused disconnect.
2. Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault.
3. Motor shall be brushless DC type with a permanent magnet rotor.
4. Fan section shall come equipped with a motor control panel mounted on the fan section. Both line voltage and low voltage wiring shall be done by the factory. Each fan shall have an isolation switch.
5. Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.

2.6 BEARINGS, SHAFTS & DRIVES

A. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be designed for service with an L-50 life of 200,000 hours and shall be a heavy duty pillow block, self-aligning, grease-lubricated ball or spherical roller bearing type.

B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

2.7 ELECTRICAL

A. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPAct requirements), 1750 RPM, single speed, 200V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.

B. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.

C. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.

D. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.

E. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.

2.8 COOLING AND HEATING COILS

A. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.

B. Water heating and cooling coils shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

1. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
2. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
3. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
4. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.

5. Coil shall be furnished as an uncased galvanized steel track to allow for thermal movement and slide into a pitched track for fluid drainage.

2.9 FILTERS

A. Furnish flat filter in mixing box section with 2-inch pleated MERV 13 filter with microbial resistant Intersept coating. Provide side loading and removal of filters.

B. Filter media shall be UL 900 listed, Class I or Class II.

C. Filter Magnehelic gauge(s) shall be furnished and mounted by equipment manufacturer.

2.10 HEAT EXCHANGER – ENTHALPY WHEEL

A. The device shall be an aluminum substrate with 4 angstrom molecular sieve desiccant.

B. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.

C. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

D. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.

E. Energy recovery wheel media shall be constructed of fluted aluminum with permanently-bonded zeolite desiccant.

F. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.

G. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.

H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.

I. Rotor media shall be reinforced using aluminum structural spokes with extruded central hub and shaft and shall be connected to shaft using pillow bearings.

J. Energy wheel cassette shall include seals, drive motor, and linked drive belt.

K. Latent energy shall be transferred entirely in the vapor phase with no condensation.

L. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories Recognized Component for electrical and fire safety.

M. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.

2.11 ADDITIONAL SECTIONS

A. Face and bypass section shall be provided to modulate airflow through and around heat transfer coils. Dampers shall be an integral part of the unit assembly. Internal face and top bypass shall be contained in the standard cabinet height. Blank-off and division sheets, internal linkage, access installed by unit manufacturer. Face and bypass dampers shall be of low leak design, opposed blade, with vinyl bulb edging and stainless steel edge seals, galvanized steel frame and axles in self-lubricating nylon bearings.

B. Mixing box section shall be provided with top outside air opening and end return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

2.12 CONTROLS

A. ATC devices shall be provided and field mounted by the BAS Manufacturer. The contractor shall coordinate these requirements.

B. Combination Starter-Disconnects:

1. Provide combination starter-disconnect for each fan motor.
2. Factory mount in full metal enclosure and wire to fan motor.
3. Mount starter-disconnect on fan section externally in a NEMA 1 enclosure within a dedicated controls section or housed fan section.
4. Include circuit breaker disconnect with through-the-door interlocking handle for externally mounted starters, spring loaded, and designed to rest only in the full and lockable ON or OFF state.
5. Allow enclosure entry via a concealed defeater mechanism when the handle is in the ON position.
6. Include the following items:
    a. Hand-Off-Auto (H-O-A) switch.
    b. Two normally open auxiliary contacts.
    c. Overload heaters.
    d. 120V control transformer with fusing and secondary grounding.
7. Include power wiring from the starter control transformer to the secondary control system transformers, and start-stop wiring from the direct digital controller start-stop relay to the starter H-O-A switch.

C. Combination VFD - Disconnects:

1. Provide factory mounted, combination VFD - disconnect in accordance with Section 26 29 23 for each fan motor.

2. Factory mount in full metal enclosure and wire to fan motor.
3. Mount VFD-disconnect on fan section externally in a NEMA 1 enclosure within a dedicated controls section or housed fan section.
    a. Internal Enclosure Construction Characteristics:
        1) Integral part of unit casing to allow for thermal venting to casing interior.
        2) Accessible from unit exterior via access door.
        3) Construction of access doors same throughout unit.
4. Include circuit breaker disconnect with through-the-door interlocking handle for externally mounted starters, spring loaded, and designed to rest only in the full and lockable ON or OFF state.
5. Include control transformer with sufficient capacity to support the following items:
    a. VFD and controls.
    b. Binary output on-off wiring.
    c. Analog output speed-signal wiring.
    d. All interfacing wiring between the VFD and the direct digital controller.
6. Provide bypass relays and bypass circuitry with VFD-OFF-BYPASS selector switch.

2.13 ROOF CURBS.

A. Vibration isolation roof curbs shall be provided by the rooftop unit manufacturer. Refer to section 23 05 49 to clarify requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Bolt sections together with gaskets.

C. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

D. Provide sheaves required for final air balance.

E. Hydronic Coils:

1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
3. Locate water supply at bottom of supply header and return water connection at top.
4. Provide manual air vents at high points complete with stop valve.
5. Ensure water coils are drainable and provide drain connection at low points.

F. Insulate coil headers located outside air flow as specified for piping. Refer to Section 23 07 19.

G. Field-wire all factory provided controls for field installation.

END OF SECTION 237313

SECTION 238101 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Convectors.

B. Unit heaters.

C. Cabinet unit heaters.

D. Vertical classroom ventilators.

E. Fan coil units.

1.2 RELATED SECTIONS

A. Section 230513 - Common Motor Requirements for HVAC Equipment.

B. Section 230993 - Sequence of Operations for HVAC Controls.

1.3 SUBMITTALS

A. Product Data: Provide typical catalog of information including arrangements.

B. Shop Drawings:

1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
3. Indicate mechanical and electrical service locations and requirements.,

C. Manufacturer's Instructions: Indicate installation instructions and recommendations.

D. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.

E. Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 WARRANTY

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

1.6 EXTRA MATERIALS

A. See Division 1 - Product Requirements, for additional provisions.

PART 2 - PRODUCTS

2.1 CONVECTORS

A. Manufacturers:

1. Sterling Hydronics.
2. Rittling.
3. Modine.

B. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and cast iron headers, steel side plates and supports, factory air pressure tested at 100 psi under water, with means of adjusting pitch of element.

C. Cabinet: 0.0598 inch steel front and top, 0.0478 inch steel back and ends; exposed corners rounded; easily secured removable front panels, adequately braced and reinforced for stiffness.

D. Finish: Factory applied baked enamel of color as selected.

E. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.

F. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 x 7 inch minimum size, integral with cabinet.

2.2 UNIT HEATERS

A. Manufacturers:

1. Sterling Hydronics.
2. Rittling.
3. Modine.

B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

C. Casing: 0.0478 inch steel with threaded pipe connections for hanger rods.

D. Finish: Factory applied baked primer coat.

E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

F. Air Outlet: Adjustable pattern diffuser on projection models and two way louvers on horizontal throw models.

G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.

H. Control: Local disconnect switch.

I. Capacity: As scheduled, based on 65 degree F entering air temperature, 180 degree F average water temperature.

2.3 CABINET UNIT HEATERS

A. Manufacturers:

1. Sterling Hydronics.
2. Rittling.
3. Modine.

B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 220 degrees F.

C. Cabinet: 0.0598 inch steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet.

D. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.

E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.

G. Control: Multiple speed switch, factory wired, located in cabinet.

H. Filter: Easily removed 1 inch thick permanent washable type, located to filter air before coil.

2.4 VERTICAL CLASSROOM UNIT VENTILATOR:

A. Manufacturer:

1. The unit shall be as manufactured by Airdale.

B. General Specifications

1. The unit shall be a chilled water cooling/hot water heating unit ventilator. The unit shall be floor-mounted and vertically configured to allow supply air to be ducted or supplied through a high level plenum. All access and maintenance shall be through the front of the unit.
2. The unit shall be constructed in accordance with ETL & CSA standards, and a label shall be affixed to the unit listing the product code under which it is registered.
3. The unit shall be a product of ISO: 9001 quality control program and be fully assembled and tested prior to shipment.

C. Cabinet

1. The cabinet shall be constructed from galvanized sheet steel. Prior to assembly, the cabinet parts shall be degreased and coated with a dry powder, epoxy resin paint, baked after application, standard color shall be hammertone beige. The paint finish shall be easily cleanable and hard wearing to give maximum protection. The cabinet shall be insulated with acoustic foam insulation containing no fibrous materials. The foam insulation shall have a fire rating of UL94HF-1.
2. The front of the unit shall contain a low-level tamperproof return air grille integral to front of the door and a sound attenuating inlet plenum. The door shall be hinged with a spring-loaded pin to allow for easy removal if required. Doors shall be secured with a two key locks.
3. The back of the cabinet shall have an opening for connection to a wall sleeve and louver. Knockouts for field piping connections shall be located at the top and lower sides of the unit. All factory installed pipework shall be fully insulated with 3/8” wall closed cell type insulation.

D. Coils

1. Twin large surface area coils shall be arranged in an 'A' frame configuration to optimize heat transfer and airflow.
2. Separate coil assemblies shall be utilized for all the units within the range. Standard and high capacity chilled water coil assemblies, standard and high capacity hot water coil assemblies, four pipe chilled water & hot water coil assemblies, and also refrigerant cooling coils shall be used dependent on unit configuration. Each coil shall be manufactured from refrigeration quality 3/8” diameter cooper tubing mechanically bonded onto aluminum fins with coil circuitry designed to ensure minimum waterside pressure drops. Each coil shall be fitted with an air bleed at the high point of the coil and a drain plug at the low point. All coils subject to chilled water flow shall be mounted in an ABS vacuum formed condensate tray.
3. All coil assemblies shall be factory installed and piped to the standard unit connections.

E. Supply Fan & Fan Motor

1. Supply airflow shall be provided by a double inlet, forward curved, centrifugal fan with integral direct drive motor. The assembly shall be statically and dynamically balanced to ensure smooth running and minimum noise levels. The fan motor shall be an electronically commutated motor (ECM). The ECM motor will have a wide range of programmable speed and torque characteristics for ultra-low noise while delivering constant air flow. The exhaust fan shall employ a permanent split capacitor type fan motor with integral automatic thermal overload protection.
2. The fan assembly shall be positioned for a “blow through” configuration, to maximize the mixing of outside air and room air before the air passes over the coil(s).

F. Filter

1. Each unit shall be fitted with 2” thick pleated disposable synthetic filters designed to meet with a Minimum Efficiency Reporting Value (MERV) 13 rating. The filter shall be accessible from the front of the unit for easy replacement, however it shall be mounted in a position so that all return and outdoor air shall be filtered prior to being conditioned. The filter shall be treated with a durable, low toxicity, broad-spectrum antimicrobial that inhibits the growth of bacteria and fungi on the filter surfaces.

G. Economizer

1. Each unit shall be fitted with a spring return modulating damper that acts to mix the outdoor air with the return air. The damper shall have the capability of permitting only the outside air into the space, or recycling the return air and allowing only a minimum of outside air to enter the space. Full modulation allowing any mixture of outside air and return air shall be possible. A minimum damper position setting shall also be possible to continuously maintain outside air ventilation requirements dependent on control via the unit's microprocessor controller.
2. The damper blade shall pivot on self-lubricating nylon bearings and modulate using an electronically controlled damper actuator.

H. Control Panel

1. The control panel shall contain a 24-volt control circuit transformer and all necessary contactors, relays and circuit breakers to provide the necessary control. All components located in the panel shall be clearly marked for easy identification. All terminal blocks and wires shall be individually numbered. All electrical wires in the control panel shall be run in an enclosed trough. Wiring outside the control panel shall be run in protective sleeving.

I. Microprocessor Controls

1. The microprocessor controller and associated control hardware shall be supplied to Airedale for factory installation and testing. Strategy, wiring diagrams, microprocessor and sensors shall be supplied to Airedale.

J. Factory Installed

1. 3 Speed Switch: A 3 speed switch shall be internally mounted to enable the adjustment of the supply air volume.
2. Disconnect Switch: The unit shall be fitted with a power disconnect switch located on the control panel, sized for the full load amperage of the unit to enable the unit to be disconnected from the power supply prior to any maintenance. In the off position the switch can be locked out.
3. Freeze Protection: The unit shall be fitted with a freeze protection sensor to prevent any freezing of the hot water coil assembly. When the sensor detects a freeze up condition it shall shut the damper and force the flow control valve open and prevent the unit supply fan from running.
4. Control Valve: A modulating two-way Belimo valve(s) shall be provided by the ATC contractor for factory piping and installation in the unit by Airedale to provide precise capacity control of hot water and chilled water coils. The capacity control valve(s) shall be controlled by the unit mounted controller supplied by others.
5. Valve Packages: In addition to the control valve(s) the unit shall be shipped with loose assemblies containing circuit setter(s), manual shut-off valves and strainer(s) for field installation. Units will accept either top or bottom entry piping as required. When a top piping connection is required the side piping enclosure must be utilized and the Mechanical contractor must cut access into the unit ventilator before mounting the pipe enclosure.
6. Unit Color: Standard color shall be baked enamel with hammertone beige finish.

K. Accessories - Field Installed:

1. Wall Sleeve: The wall sleeve shall be constructed from galvanized steel. An interior separator plate running the entire length shall separate the fresh air inlet from the exhaust air. The sleeve shall be proved by Airedale and insulated by the installing contractor with foil back insulation. The wall sleeve shall be of a telescoping type able to be adjusted 10-16 inches. Wall sleeves shall be provided where indicated on the schedule drawings.
2. Outside Air Rear Extension: Where site conditions do not permit the use of the standard locations for outside air intake and exhaust air discharge, an outside air rear extension shall be supplied for site installation by the mechanical contractor.
3. Custom Accent Panels: When an outside air rear extension is used, a custom fabricated accent panel shall be provided to be mounted adjacent to the unit ventilator to cover part of the existing window/sill. The accent panels are painted to match the unit and shall be shipped separately for field mounting and final trimming by the Mechanical contractor.
4. Rear Filler Panels: When an outside air rear extension is used in conjunction with a plenum, rear filler panels are used to fill the gap between the rear of the plenum and the wall. Rear filler panels are painted to match the unit and shall be shipped separately for field mounting.
5. Plenum: A factory supplied discharge plenum painted to match the unit shall be field mounted on top of the unit. Plenums are available from 12” to 48” high in 2” increments. The discharge plenum shall supply air through the top only, the front and/or either side as required. Plenums with front and side discharge shall be supplied with aluminum grills with a clear anodized finish. The plenum shall be lined with acoustic foam to minimize noise levels. The plenum shall be shipped separately for field mounting, hardware provided. Plenums shall be provided where indicated on the schedule drawings.
6. Discharge Duct Flange: The 1” inch factory fitted discharge duct flange shall be supplied to allow for easy installation of a discharge duct to the unit.

7. Louver: Outdoor louver furnished by Airedale suitable for masonry, glass, or panel wall construction. Louver is flanged style with bird screen and provided in an aluminum and kynar finish with a color selected by the Architect. Louvers shall be provided by this manufacturer only where indicated on the schedule drawings.
8. Factory Start-up & Training: Airedale shall provide start-up and customer training for the supplied equipment. Start-up will be coordinated with the local representative.

2.5 FAN-COIL UNITS

A. Manufacturers:

1. Daikin.
2. Carrier.
3. Johnson Controls Inc.

B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 200 psi (1380 kPa) and 220 degrees F. (104 degrees C.). Provide drain pan under cooling coil, easily removable for cleaning, with drain connection.

C. Cabinet: 0.0598 inch (1.5 mm) steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet.

D. Finish: Factory apply baked primer coat on visible surface of enclosure or cabinet.

E. Fans: Supply fans shall be a DWDI forward-curved type. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.

F. Motor: An ECM blower motor shall be provided on all units. Factory motor wiring shall be set for optimum fan performance. The unit shall be shipped at one fixed setting. The ECM motor shall utilize a permanent magnet rotor, which is connected to the shaft through resilient rings to absorb high frequency torque ripple. ECM motor shall be programmed for constant CFM or constant torque.

G. Control: Multiple speed switch, factory wired, located in cabinet.

H. Filter: Easily removed 1 inch (25 mm) thick glass fiber throw-away type, located to filter air before coil.

I. Capacity: As Scheduled, based on 65 degrees F. (18 degrees C) entering air temperature, 180 degree F (82 degree C) average water temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Do not damage equipment or finishes.

C. Protection: Provide finished cabinet units with protective covers during balance of construction.

D. Convectors: Install where indicated. Coordinate to assure correct recess size for recessed convectors.

E. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

F. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.

3.2 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters.

END OF SECTION 238101

SECTION 238127 - SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air cooled condensing units.

B. Indoor ductless fan & coil units.

C. Controls.

1.2 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.

B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.

C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.

D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE Std 15).

E. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.

G. UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

D. Design Data: Indicate refrigerant pipe sizing.

E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

F. Project Record Documents: Record actual locations of components and connections.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

H. Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in Owner’s name and registered with manufacturer.

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

1. Extra Filters: One for each unit.

1.4 QUALITY ASSURANCE

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

1.5 WARRANTY

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

B. Provide five year manufacturer’s warranty for compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Daikin.

B. Mitsubishi.

C. EMI.

2.2 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.

1. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

2.3 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

1. Construction and Ratings: In accordance with AHRI 210/240 and UL listed.

2.4 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

1. Comply with AHRI 210.
2. Refrigerant: R-410A.
3. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL listed.

B. Compressor: AHRI 520; hermetic, two speed 1800 and 3600 rpm, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.

C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).

1. Provide thermostatic expansion valves.

D. Operating Controls:

1. Control by room thermostat to maintain room temperature setting.
2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to 0 degrees F.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.

B. Install in accordance with NFPA 90A.

C. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION 238127

SECTION 238313 - RADIANT-HEATING CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Heating cable.

B. Temperature controllers for heating cable.

1.2 RELATED SECTIONS

A. Section 232113 - Hydronic Piping

B. Section 230719 - HVAC Piping Insulation.

C. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Division 1 – Summary of the Project.

1.3 PERFORMANCE REQUIREMENTS

A. Pipe Trace Heating: Freeze protection with outside temperature at -10 degrees F (-23 degrees C).

1.4 SUBMITTALS

A. See Division 1 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for heating cable and control components.

C. Shop Drawings: Indicate heating cable layout, locations of terminations, thermostats, and branch circuit connections.

D. Manufacturer's Installation Instructions: Indicate installation instructions.

E. Project Record Documents: Accurately record actual locations of heating cable and branch circuit connections.

F. Operation Data: Include description of operating controls.

G. Maintenance Data: Include repair methods and parts list of components.

1.5 QUALITY ASSURANCE

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

1.6 PRE-INSTALLATION MEETING

A. Convene one week prior to commencing work of this section.

B. Require attendance of parties directly affecting the work of this section.

C. Review sequencing of installation, protection from damage of finished installation, location of expansion and control joints in building, and methods used for covering installations with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Chromalox; Model SRL

B. Orbit

C. Nexans

2.2 HEATING CABLE

A. Heating Cable: Self-limiting, parallel resistance heating cable.

2.3 ACCESSORIES

A. Thermostats:

1. Chromalox
2. Orbit
3. Nexans

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping is ready to receive work.

B. Verify field measurements are as shown on shop drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Avoid pinching and making sharp bends in cable.

C. Do not install heating cable across expansion or construction joints.

D. E.C. shall provide a service to the proximity of the cable locations. H.C. shall provide junction box and all interconnecting wiring between the E.C. service and the cables. H.C. shall be responsible for the final connection to the E.C. service.

3.3 FIELD QUALITY CONTROL

A. Test continuity of heating cable.

B. Perform tests on completed cable installation. For cables embedded in concrete, perform tests immediately before and after concrete placement.

C. Measure voltage and current at each unit.

3.4 DEMONSTRATION

A. Demonstrate operation of heating cable controls.

END OF SECTION 238313

SECTION 260100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SCOPE OF PROJECT:

A. Provide a complete and operating electrical installation in accordance with these specifications and accompanying contract drawings. This includes all required labor, materials, apparatus and supervision.

B. Without limiting or restricting the volume of work and solely for the convenience of the Contractor, the work to be performed in general, comprises the following:

1. Temporary lighting.
2. Temporary power to construction trailers and building construction power.
3. Upgraded electrical service.
4. Complete lighting and automatic lighting control systems.
5. Complete building power system.
6. Flash-arc labeling.
7. Final connections to all equipment, unless otherwise noted.
8. New Verizon and Comcast service.
9. New indoor gas-fired emergency system with a new automatic transfer switch, including all new devices associated with the connections to the portable generator.
10. New PA system.
11. New Siemens addressable fire alarm and detection system throughout the building.
12. New LED theatrical lighting system and sound-reinforcement system for the cafeteria.
13. New sound-reinforcement systems for the gymnasium and music classroom.
14. Control wiring for Division 23 equipment where shown on Division 26 documents.
15. New Structured Cabling System.
16. Training of all new and systems.
17. New access control system.
19. Fire-proofing where required per code.
20. Coordination with other contractors.

1.3 INTENT OF THIS SECTION:

A. This Section is intended as a supplement to each of the following Sections of Division 26, 27, 28 and 31 ELECTRICAL.

B. Consider each article of this Section as a part of each of the following Sections insofar as such requirements may be termed applicable.

1.4 TRUE INTENT:

A. The Drawings and Specifications are intended to provide a complete and perfectly operating system. Therefore, it is specifically agreed and understood by the Contractor that anything, be it labor, material or equipment, which is not described in the Specifications or specifically shown on the Drawings, but is necessary for the operation and completion of a perfectly operating system, according to the true intent of the Specifications and Drawings and as interpreted by the architect, shall be furnished by the Contractor as a part of his Contract, at no extra charge, as though it were specifically detailed and described.

1.5 DEFINITIONS:

A. General - Basic Contract definitions are included in the Conditions of the Contract.

B. Indicated - The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.

C. Directed - Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.

D. Approved - The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications and requests, is limited to the Architects duties and responsibilities as stated in the Conditions of the Contract.

E. Regulation - The term regulation includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation and similar operations.

G. Install - The tem install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. Provide - The term provide means to furnish and install, complete and ready for the intended use.

I. Contractor - The Contractor or Electrical Contractor - The term means the Contractor responsible for all work under this section.

J. Installer - An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term experienced, when used with the term installer, means having a minimum of five previous projects similar in size and scope to this project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
2. Trades - Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
3. Assigning Specialists - Certain Section of the Specifications require that specific construction activities are performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
    a. This requirement is not to be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

K. Testing Agencies - A testing agency is an independent entity engaged to perform specific inspections or tests, both at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.6 VISITS TO SITE:

A. Attention is directed to the necessity for all the Electrical Contractor to visit the site and examine all conditions affecting the proper execution of this Contract. Submission of proposals shall be considered evidence that Contractors have visited and examined the site.

B. Existing contours and topography as indicated, are believed to be reasonably correct, but are not guaranteed. Where conditions at project site do not agree exactly with conditions as indicated, Contractor shall assume all responsibility for said discrepancy.

C. No extra payment will be allowed the Electrical Contractor for extra work caused by failure to visit, examine and clarify.

1.7 GENERAL:

A. Throughout the Specifications, types of material are specified by manufacturer's name. Where more than one manufacturer is mentioned, catalog and specification data is given for a specific manufacturer. Equal material produced by other manufacturers listed is acceptable. Refer to PRODUCT REQUIREMENTS - Division 1 for substitution of materials.

1.8 RULES AND REGULATIONS

A. Perform in accordance with the rules and regulations of the National Electric Code (NEC), International Building Code (IBC) and other Codes and Standards cited in this specification and the requirements of the Utility Companies serving this project.

B. Certificates of Approval in triplicate, for rough and finished wiring from a Certified Inspection Service must be delivered to the Engineer before final payment can be authorized.

C. Perform all work in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration) and any other national, state, or local authority having jurisdiction.

D. Perform all Construction, design, fabrication, tests, rating, and installation in compliance with the regulations of all local, state or national agencies having jurisdiction over the project. Pay all costs involved in work necessary to comply with these regulations.

E. The Contractor assumes all responsibility and liability for any code violations, damage or injury which occurs as a result of deviation from or a change to the requirements of these plans and specifications which has not been approved in writing by the Engineer.

1.9 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW:

A. Submit Shop Drawings in accordance with SUBMITTALS Division 1 and as indicated in subsequent Sections of this Division. Assume responsibility for quantities and correct mounting details. In addition, submit other shop drawings as may be requested by the Architect. Provide the following shop drawings including, but not limited to:

1. Overcurrent Coordination Study
2. Arc Flash Study.
3. Metal Clad Cable
4. Building Wire
5. Conduit
6. Fittings
7. Wireways
8. Outlet Boxes
9. Floor Boxes
10. Switches
11. Receptacles
12. Wall Plates
13. Occupancy Sensors & Automatic Lighting Controls
14. Dimmer Switches
15. Switchboard Breakers
17. Panelboards
18. Safety Switches and fuses
19. Circuit Breakers
20. Lighting Fixtures including lamp and ballast or driver information
21. Theatrical Lighting equipment
22. Fire Alarm & Detection System Equipment
23. Emergency Generator and associated equipment
24. Automatic Transfer Switches
25. PA and Master Clock Equipment
26. Structured Cable System Equipment
27. Sound Reinforcement System Equipment

1.10 DRAWINGS:

A. The Electrical drawings are indicative of the general arrangements and approximate sizes and relative locations of principal materials to be provided. Drawings are diagrammatic and are a graphic representation of contract requirements to best available standards at the scale required. Provide certain items such as pull boxes, offsets to clear interferences, and supports which are not specifically shown but which are obviously needed to make the system complete and operable.

B. Verify all grades, elevations, dimensions and clearances at the site.

C. Electrical riser and schematic diagrams generally indicate wiring to be used in various systems. Provide all work shown on diagrams whether or not it is duplicated on the plans.

D. All drawings and specifications pertaining to general construction, plumbing, HVAC, kitchen, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to coordinate with other trades, this Contractor shall rearrange his work at his own experience.

1.11 ENVIRONMENTAL CONDITIONS:

A. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions or temperature in area or moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.

1.12 PROTECTION:

A. Provide effective protection against damage for all materials and equipment during shipment, and storage at the Project site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.

B. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.

C. Protect all rough and finished floors and finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor coverings. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

1.13 PRODUCT:

A. Have materials delivered to site. Unload and store materials in allotted location, and protect from damage. Deliver materials to their point of installation.

B. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

1.14 COMPLIANCE WITH GENERAL STANDARDS AND REGULATIONS:

A. Provide equipment that is in conformity with these specifications and applicable requirements of the following:

1.	AASHTO	American Assoc. of State Highway and Transportation Officials
2.	ACI	American Concrete Institute
3.	AISC	American Institute of Steel Construction
4.	AISI	American Iron and Steel Institute
5.	ANSI	American National Standards Institute
6.	ASTM	American Society for Testing and Materials
7.	AWS	American Welding Society
8.	CBM	Certified Ballast Manufacturers Assoc.
9.	CRSI	Concrete Reinforcing Steel Institute
10.	EIA	Electronic Industries Assoc.
11.	ETL	ETL Testing Laboratories Inc.
12.	FM	Factory Mutual Research Assoc.
13.	ICEA	Insulated Cable Engineers Association, Inc.
14.	IEC	International Electrotechnical Commission
15.	IEEE	Institute of Electrical and Electronic Engineers
16.	IESNA	Illuminating Engineering Society of North America
17.	IMSA	International Municipal Signal Association
18.	LPI	Lighting Protection Institute
19.	NEC	National Electric Code
20.	NECA	National Electrical Contractors Association
21.	NEMA	National Electrical Manufacturers Association
22.	NETA	International Electrical Testing Association
23.	NFPA	National Fire Protection Association
24.	UL	Underwriters Laboratories, Inc

1.15 COMPLIANCE WITH FEDERAL GOVERNMENT AGENCIES

A. Names and titles of federal government standard - or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard - Specification-producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to the date of the Contract Documents.

1.	ADA	Americans with Disabilities Act
2.	CFR	Code of Federal Regulations
3.	EPA	Environmental Protection Agency
4.	FAA	Federal Aviation Administration (US Dept. of Transportation)
5.	FCC	Federal Communication Commission
6.	FS	Federal Specification (from GSA); Specifications Unit (WFISIS)
7.	MIL	Military Standardization Documents (US Department of Defense) Naval Publications and Forms Center
8.	OSHA	Occupational Safety and Health Administration (US Department of Labor)
9.	REA	Rural Electrification Administration (US Department of Agriculture)

1.16 GUARANTEE:

A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year from date of Final Payment. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.

B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.

C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

PART 2 - PRODUCTS

2.1 Refer to Division 26 – ELECTRICAL, Division 27 – COMMUNICATIONS, Division 28 - ELECTRONIC SAFETY AND SECURITY and Division 31 – EARTHWORK.

PART 3 - EXECUTION

3.1 LOCATION OF MATERIAL:

A. Locate all lighting fixtures, power apparatus, conduit, outlets and other materials to result in proper operation of the building and to avoid conflicts with the work of other trades. Obtain required location information sufficiently in advance of installation time to allow uninterrupted progress of the work. Check layouts of equipment with shop drawings of all trades to determine roughing-in requirements. Do not scale drawings for exact locations. Exercise proper judgment to secure a neat arrangement of conduit, piping, ductwork and other material; and to overcome local interferences to best advantage of the Project.

B. Where physical interferences cannot be resolved readily, consult with the Engineer and Architect and prepare dated, dimensioned drawings correcting the interferences. Obtain written approval of the Engineer and Architect for such changes and distribute the drawings to all interested parties as directed by the Engineer and Architect.

C. In modular panel ceilings, locate lights, detectors and similar equipment as shown on reflected ceiling plan. Arrange ceiling outlets symmetrically.

D. Locate switches and other manually operated devices in a location easily accessible and convenient to operating personnel. If any such devices are mounted in a location deemed inaccessible or impractical, relocate devices at no increase in contract costs.

3.2 EARTHWORK:

A. Provide all excavation, backfill, shoring and similar work as required for the installation of the Work of this Division. Refer to the requirements of Excavation and Division 31.

B. Protect roots of live trees encountered in excavation.

C. Where excavations at footings, foundations, and other structures are deeper than the angle of repose deemed adequate by Architect, backfill such excavations solidly with 3000 pound concrete.

D. Remove and dispose of excess excavated materials as directed by the Engineer or Architect.

3.3 FLASHING AND COUNTERFLASHING:

A. The Roofing Contractor shall provide metal flashing and counterflashing for Division 27 and 28 installations in accordance with SHEET METAL, Division 7, for all conduits penetrating the roof. Form counterflashing into a rainhood attached to conduit and passed down over top of flashing. Attach counterflashing to conduit with clamp, and waterproof with sealing compound.

B. Base flashing will be worked into roofing.

3.4 CHASES AND OPENINGS:

A. Openings, recesses and chases will be provided in the building construction as described in GENERAL CONDITIONS. Make detailed dimensioned drawings under Division 27 and 28 where required by Architect.

3.5 CUTTING AND PATCHING:

A. The EC shall perform all cutting of existing building construction under Division 26, 27 and 28 as required for installation of electrical work.

B. The EC shall perform cutting carefully so as not to damage the structure or leave unsightly surfaces that cannot be covered with plates, escutcheons, or other normal concealing construction.

C. The GC shall be responsible for the repair of all adjacent construction and finishes that are visible and are damaged during the installation of electrical devices and extension of such work. The EC shall repair all construction that is not visible but requires repair to maintain construction integrity.

D. Refer to 260538 Firestopping for additional requirements.

3.6 CONCRETE:

A. Provide all concrete required for the work of Division 31 - EARTHWORK, unless otherwise noted. Provide 3000 pound concrete in accordance with the provisions of Division-CONCRETE.

B. The GC shall provide concrete equipment pads for all freestanding electrical equipment inside the building, unless otherwise noted.

3.7 MOTOR STARTERS

A. Furnish all manual motor starters, and mount where shown on drawings.

B. Mount manual motor starters for roof fans in an accessible location inside the building to avoid affecting thermal devices by atmospheric conditions.

C. In general, magnetic motor starters will be delivered to the site by the HC with the equipment they control.

1. Starters furnished under Division 21, 22, and 23 will be delivered to the Electrical Contractor for installation and wiring. The Electrical Contractor shall mount the starters where shown on the Drawings, and provide power wiring to the starter, as well as power wiring from the starter to the motor. Control wiring will be provided under the HVAC Contract.
2. Equipment furnished under other Divisions and under other contracts generally will not be combination type. Provide disconnects as required by the NEC within site of the controller and motor.
3. Check running current of each motor and verify correct size of overload elements, and fuses in combination starters. Notify Architect in writing of all overload elements and fuses incorrectly sized, so that corrective action can be initiated.
4. Prepare a typewritten list of all motors in the project, and submit to Architect for delivery to the Owner. Include the following information for each motor:
    a. Function and nomenclature, as identified by the marking actually used in the field.
    b. Physical location in the building.
    c. Rated horsepower, voltage and phase.
    d. Rated full load current.
    e. Proper size of thermal overload element.
    f. Mount all motor starters, except those factory mounted on equipment.

3.8 COLOR CODING OF WIRING

A. Color code all wiring in accordance with the following table. In general, use factory colored insulation. Use colored vinyl tape for black insulation on cables No. 8 and larger. Apply pressure sensitive tape in half-lap serving for distance of 6" at cable terminations, in pull boxes, manholes, panels, and similar locations.

	Phase	208/120 Volts
2.	Phase "A"	Black
3.	Phase "B"	Blue
4.	Phase "C"	Red
5.	Neutral	White
6.	Equipment ground	Green

3.9 PHASING

A. Phase building load centers and panelboards "A", "B", "C" top to bottom and left to right. Identify the neutral, although it may be in different locations for different equipment.

B. Connect transformers in all systems so that:

1. "A" Phase is terminated at "H1" connection.

2. "B" Phase is terminated at "H2" connection.
3. "C" Phase is terminated at "H3" connection.
4. "X1" connection shall be the "A" Phase.
5. "X2" connection shall be the "B" Phase.
6. "X3" connection shall be the "C" Phase.

C. Ascertain from Power Company phase identifications at the point of connection and thereafter carry out and maintain this consistent system of color coding, phase identification and positioning.

D. Verify phase rotation after all terminations at equipment have been made, by producing a 1-2-3 rotation on a phase sequence meter when connected to "A", "B", and "C" phases. Make phase rotation compatible with existing distribution system.

3.10 GROUNDING RESISTANCE TEST:

A. Provide grounding system resistance test to verify resistance. Maximum resistance shall be 5 ohms.

B. Send final certified test reports and Certifications to Engineer for approval and transmittal to the Owner in accordance with SUBMITTALS, Division 1.

3.11 INSPECTION AND CERTIFICATION:

A. Obtain and deliver a final Certificate of Approval from the applicable NEC inspection authority having jurisdiction. Make delivery to Engineer for transmittal to the Owner upon completion of the work and before final payment in accordance with PROJECT CLOSE-OUT, Division 1. Pay all charges made by the inspection authority and include their cost in the bid. Also, the contractor shall initiate the inspection made by the Township Building Code Official. The Owner shall pay for the Township inspection.

3.12 INSTALLATION:

A. Install equipment in accordance with manufacturer's recommendations.

3.13 EQUIPMENT BY OWNER:

A. The Owner will furnish certain equipment, and deliver this equipment to the site as stated in EQUIPMENT FURNISHED BY OWNER, Division 11. Provide final electrical connections as required.

3.14 AS-BUILT DRAWINGS:

A. During construction, the Contractor shall maintain a record set of installation prints. He shall record on these prints all deviations from the Contract Drawings in conduit sizing, location, and details. The record set of installation prints shall be updated at the end of each month and shall be reviewed by the Engineer and the Owner.

B. At the completion of the work, the Contractor shall forward these prints to the Engineer and the Architect for incorporation into the final As-Built Drawings.

3.15 UTILITY CONTACTS:

A. PECO (electric) –

B. Verizon –

C. Sunesys –

E. Comcast -

3.16 INSTRUCTION TO EMPLOYEES:

A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.

B. Three copies of factory maintenance schedules shall be furnished for each of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.

C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

D. Instructions described shall be given for the following systems:

1. Fire Alarm & Detection System.
2. PA & Master Clock System.
3. Theatrical Lighting and Sound System.
4. Lighting control systems.

END OF SECTION 260100

SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition.

1.2 RELATED REQUIREMENTS

A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 72 hours before partially or completely disabling system.
2. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.

1. Notify Owner before partially or completely disabling system.
2. Notify local fire service.

F. Existing Low-Voltage Systems: Maintain existing systems in service until new system is complete and ready for service. Disable systems only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 72 hours before partially or completely disabling systems.
2. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:

1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
2. PCB- and DEHP-containing lighting ballasts.
3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION 260505

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Single conductor building wire.

B. Metal-clad cable.

C. Wire and cable for 600 volts and less.

D. Wiring connectors.

E. Electrical tape.

F. Heat shrink tubing.

G. Wire pulling lubricant.

1.2 RELATED REQUIREMENTS

A. Section 078413 – Penetration Firestopping.

B. Section 078443 – Joint Firestopping.

C. Section 079200 – Joint Sealants

D. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

E. Section 283100 - Fire Detection and Alarm: Fire alarm system conductors and cables.

F. Section 315000 – Excavation Support and Protection.

G. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2001 (Reapproved 2007).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010.

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2009).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2008.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association; 2006.

I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).

J. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

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

L. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

N. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

O. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

P. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

R. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Product Data: Provide for each cable assembly type.

D. Test Reports: Indicate procedures and values obtained.

E. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

F. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

G. Project Record Documents: Record actual locations of components and circuits.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted.

F. Armored cable is not permitted.

G. Metal-clad cable is permitted only as follows:

1. Where not otherwise restricted, may be used:
   a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
      1) Maximum Length: 6 feet.
   b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
      1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
2. In addition to other applicable restrictions, may not be used:
   a. Where not approved for use by the authority having jurisdiction.
   b. Where exposed to view.
   c. Where exposed to damage.
   d. For damp, wet, or corrosive locations.
   e. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.

H. Concealed Dry Interior Locations: Use only building wire with Type THHN insulation in raceway.

I. Exposed Dry Interior Locations: Use only building wire with Type THHN insulation in raceway.

J. Above Accessible Ceilings: Use only building wire with Type THHN insulation in raceway.

K. Wet or Damp Interior Locations: Use only building wire with Type THWN insulation in raceway.

L. Exterior Locations: Use only building wire with Type THWN insulation in raceway.

M. Underground Installations: Use only building wire with Type THWN insulation in raceway.

N. Use solid conductor for feeders and branch circuits 10 AWG and smaller.

O. Use stranded conductors for control circuits.

P. Use conductor not smaller than 12 AWG for power and lighting circuits.

Q. Use conductor not smaller than 18 AWG for control circuits.

R. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

S. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

2.2 CONDUCTOR AND CABLE MANUFACTURERS

A. Cerro Wire LLC: www.cerrowire.com.

B. Southwire Company: www.southwire.com.

C. Substitutions: See Section 016000 - Product Requirements.

2.3 ALL CONDUCTORS AND CABLES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.

C. Provide new conductors and cables manufactured not more than one year prior to installation.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

H. Conductors for Grounding and Bonding: Also comply with Section 260526.

I. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

J. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.

2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.

K. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.
   a. Exceptions:
      1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
      2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
      3) 20 A, 277 V circuits longer than 200 feet: 10 AWG, for voltage drop.
2. Control Circuits: 14 AWG.

L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

M. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
   a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
   a. 480Y/277 V, 3 Phase, 4 Wire System:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral/Grounded: Gray.
   b. 208Y/120 V, 3 Phase, 4 Wire System:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral/Grounded: White.
   c. Equipment Ground, All Systems: Green.
   d. Isolated Ground, All Systems: Green with yellow stripe.
   e. Travelers for 3-Way and 4-Way Switching: Pink.
   f. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
   g. For control circuits, comply with manufacturer's recommended color code.

2.4 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
   1. Copper Building Wire:

a. Cerro Wire LLC: www.cerrowire.com.
b. Encore Wire Corporation: www.encorewire.com.
c. Southwire Company: www.southwire.com.d. Substitutions: See Section 016000 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:

1. Feeders and Branch Circuits:
   a. Size 10 AWG and Smaller: Solid.
   b. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:

1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
   a. Size 4 AWG and Larger: Type XHHW-2.
   b. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.5 METAL-CLAD CABLE

A. Manufacturers:

1. AFC Cable Systems Inc: www.afcweb.com.
2. Encore Wire Corporation: www.encorewire.com.
3. Southwire Company: www.southwire.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:

1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide dedicated neutral conductor for each phase conductor where indicated or required.

G. Grounding: Full-size integral equipment grounding conductor.

H. Armor: Steel, interlocked tape.

2.6 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 260526.

C. Wiring Connectors for Splices and Taps:

1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

1. Manufacturers:
   a. 3M: www.3m.com.
   b. Ideal Industries, Inc: www.idealindustries.com.
   c. NSI Industries LLC: www.nsiindustries.com.
   d. Substitutions: See Section 016000 - Product Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.

1. Manufacturers:
   a. Burndy: www.burndy.com.
   b. Ilsco: www.ilsco.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
   1. Manufacturers:
      a. Burndy: www.burndy.com.
      b. Ilsco: www.ilsco.com.
      c. Thomas & Betts Corporation: www.tnb.com.
      d. Substitutions: See Section 016000 - Product Requirements.

2.7 WIRING ACCESSORIES

A. Electrical Tape:

   1. Manufacturers:
      a. 3M: www.3m.com.
      b. Plymouth Rubber Europa: www.plymouthrubber.com.
      c. Substitutions: See Section 016000 - Product Requirements.
   2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
   3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
   4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
   5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
   6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
   7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

   1. Manufacturers:
      a. 3M: www.3m.com.
      b. Burndy: www.burndy.com.
      c. Thomas & Betts Corporation: www.tnb.com.
      d. Substitutions: See Section 016000 - Product Requirements.

C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

   1. Manufacturers:
      a. 3M: www.3m.com.
      b. American Polywater Corporation: www.polywater.com.
      c. Ideal Industries, Inc: www.idealindustries.com.
      d. Substitutions: See Section 016000 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as shown on the drawings.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated and routing is not shown, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft of location shown.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.

7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
   a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
   b. Increase size of conductors as required to account for ampacity derating.
   c. Size raceways, boxes, etc. to accommodate conductors.
8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
9. Provide oversized neutral/grounded conductors where indicated and as specified below.
   a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
   b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.

B. Install products in accordance with manufacturer's instructions.

C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

D. Install metal-clad cable (Type MC) in accordance with NECA 120.

E. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

H. Terminate cables using suitable fittings.

1. Metal-Clad Cable (Type MC):
   a. Use listed fittings.
   b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

I. Install conductors with a minimum of 12 inches of slack at each outlet.

J. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

K. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other 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 078413, 078443, and 079200.

P. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Grounding and bonding components.

1.2 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 033000 - Cast-in-Place Concrete.

1.3 REFERENCE STANDARDS

A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; 1983.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.

D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

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

F. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2011.

G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

1.6 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Shop Drawings:

1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field quality control test reports.

F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested according to IEEE 81 using "point-to-point" methods.

E. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
   a. Provide continuous grounding electrode conductors without splice or joint.
   b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal Building or Structure Frame:
   a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.

4. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, located in softscape (uncovered) area.
5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
6. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
   c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

F. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:

1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

H. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:
   a. Transformers (except autotransformers such as buck-boost transformers).
   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
   c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.

3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
5. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

I. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
    a. Metal gas piping.

J. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
    a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
    b. Raceway Size: 3/4 inch unless otherwise indicated or required.
    c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
    d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

L. Pole-Mounted Luminaires: Provide grounding of all exterior parking lot poles.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 260519:

1. Use insulated copper conductors unless otherwise indicated.
   a. Exceptions:
      1) Use bare copper conductors where installed underground in direct contact with earth.
      2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
   a. Burndy: www.burndy.com.
   b. Harger Lightning & Grounding: www.harger.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
   a. Erico International Corporation: www.erico.com.
   b. Harger Lightning & Grounding: www.harger.com.
   c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.
   d. Substitutions: See Section 016000 - Product Requirements.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
   a. Erico International Corporation: www.erico.com.
   b. Galvan Industries, Inc: www.galvanelectrical.com.

c. Harger Lightning & Grounding: www.harger.com.
d. Substitutions: See Section 016000 - Product Requirements.

2.3 PRODUCTS

A. Rod Electrodes: Copper.

1. Diameter: 3/4 inch.
2. Length: 10 feet.

B. Foundation Electrodes: 2/0 AWG.

2.4 CONNECTORS AND ACCESSORIES

A. Mechanical Connectors: Bronze.

B. Exothermic Connections:

C. Wire: Stranded copper.

D. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as shown on the drawings.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. Perform inspection in accordance with Section 014000.

B. Inspect and test in accordance with NETA STD ATS except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260534 - Conduit: Additional support and attachment requirements for conduits.

C. Section 260537 - Boxes: Additional support and attachment requirements for boxes.

D. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

F. Conduit and equipment supports.

G. Anchors and fasteners.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2011.

D. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

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

G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 3x. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.
3. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Cooper Industries: www.cooperindustries.com.
    b. Erico International Corporation: www.erico.com.
    c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
    d. Thomas & Betts Corporation: www.tnb.com.
    e. Substitutions: See Section 016000 - Product Requirements.

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

1. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Cooper Industries: www.cooperindustries.com.
    b. Erico International Corporation: www.erico.com.
    c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
    d. Thomas & Betts Corporation: www.tnb.com.
    e. Substitutions: See Section 016000 - Product Requirements.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

1. Comply with MFMA-4.
2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
3. Channel Material:
   a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
4. Minimum Channel Thickness: 12 gauge.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
6. Manufacturers:
   a. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
   b. Thomas & Betts Corporation: www.tnb.com.
   c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
   d. Substitutions: See Section 016000 - Product Requirements.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

1. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2 inch diameter.
   b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
   c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
   d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
   e. Outlet Boxes: 1/4 inch diameter.
   f. Luminaires: 1/4 inch diameter.

F. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Plastic and lead anchors are not permitted.
9. Powder-actuated fasteners are not permitted.
10. Hammer-driven anchors and fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Comply with MFMA-4.
    b. Channel Material: Use galvanized steel.
    c. Minimum Channel Thickness: 12 gauge.
    d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
12. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

13. Manufacturers - Mechanical Anchors:
    a. Hilti, Inc: www.us.hilti.com.
    b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com.
    c. Powers Fasteners, Inc: www.powers.com.
    d. Simpson Strong-Tie Company Inc: www.strongtie.com.
    e. Substitutions: See Section 016000 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Conduit Support and Attachment: Also comply with Section 260534.

J. Box Support and Attachment: Also comply with Section 260537.

K. Interior Luminaire Support and Attachment: Also comply with Section 265100.

L. Exterior Luminaire Support and Attachment: Also comply with Section 265600.

M. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

N. Secure fasteners according to manufacturer's recommended torque settings.

O. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

SECTION 260534 - CONDUIT

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Flexible metal conduit (FMC).

D. Liquidtight flexible metal conduit (LFMC).

E. Electrical metallic tubing (EMT).

F. Rigid polyvinyl chloride (PVC) conduit.

G. Liquidtight flexible nonmetallic conduit (LFNC).

H. Conduit fittings.

I. Accessories.

J. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 078413 – Penetration Firestopping.

C. Section 078443 – Joint Firestopping.

D. Section 079200 – Joint Sealants

E. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC) and armored cable (Type AC), including uses permitted.

F. Section 260526 - Grounding and Bonding for Electrical Systems.

1. Includes additional requirements for fittings for grounding and bonding.

G. Section 260529 - Hangers and Supports for Electrical Systems.

H. Section 260537 - Boxes.

I. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

J. Section 262701 - Electrical Service Entrance: Additional requirements for electrical service conduits.

K. Section 271005 - Structured Cabling for Voice and Data - Inside-Plant: Additional requirements for communications systems conduits.

L. Section 31500 – Excavation Support and Protection.

M. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.

E. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; National Electrical Contractors Association; 2004.

F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.

G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.

I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.

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

K. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

L. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

M. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

N. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

P. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

Q. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

R. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Shop Drawings:

1. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

PART 2 - PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use rigid PVC conduit.
2. Exterior, Direct-Buried: Use rigid PVC conduit.
3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.
2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches

on either side of where conduit emerges.

E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.

1. Locations subject to physical damage include, but are not limited to:
   a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
   b. Where exposed below 20 feet in warehouse areas.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

M. Corrosive Locations Above Ground: Use aluminum rigid metal conduit.

1. Corrosive locations include, but are not limited to:
   a. Cooling towers.

N. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit.

O. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

1. Maximum Length: 6 feet.

P. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
   a. Transformers.
   b. Motors.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.2 PRODUCTS

A. Electrical Service Conduits: Also comply with Section 262701.

B. Communications Systems Conduits: Also comply with Section 271005.

C. Fittings for Grounding and Bonding: Also comply with Section 260526.

D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

E. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

F. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4 inch (21 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 1/2 inch (16 mm) trade size.
4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
5. Underground, Interior: 3/4 inch (21 mm) trade size.
6. Underground, Exterior: 1 inch (27 mm) trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and

compression (gland) type fittings are not permitted.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use aluminum.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying

with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.7 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Picoma: http://www.picoma.com.
4. Wheatland Tube Company: www.wheatland.com.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:

1. Manufacturers:

a. Bridgeport Fittings Inc: www.bptfittings.com.
b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
c. Thomas & Betts Corporation: www.tnb.com.
d. Substitutions: See Section 016000 - Product Requirements.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use compression (gland) type.
   a. Do not use indenter type connectors and couplings.

2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

1. Cantex Inc: www.cantexinc.com.
2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
3. JM Eagle: www.jmeagle.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.9 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.10 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

F. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

G. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
   c. Within joists in areas with no ceiling.

5. Unless otherwise approved, do not route conduits exposed:
   a. Across floors.
   b. Across roofs.
   c. Across top of parapet walls.
   d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.

8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
14. Group parallel conduits in the same area together on a common rack.

H. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.
10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

I. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.

2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.

7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

J. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

K. Underground Installation:

1. Provide trenching and backfilling in accordance with Sections 312316 and 315000.
2. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 24 inches.
   b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape in accordance with Section 260553 along entire conduit length.

L. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 033000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

M. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected

equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

N. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

O. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

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

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective conduits.

END OF SECTION 260534

SECTION 260537 - BOXES

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Floor boxes.

D. Underground handhole enclosures.

E. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

A. Section 078413 – Penetration Firestopping.

B. Section 078443 – Joint Firestopping.

C. Section 079200 – Joint Sealants

D. Section 260526 - Grounding and Bonding for Electrical Systems.

E. Section 260529 - Hangers and Supports for Electrical Systems.

F. Section 262726 - Wiring Devices:

1. Wall plates.
2. Floor box service fittings.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010) (ANSI/NEMA OS 1).

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

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

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

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

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

J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, floor boxes, and underground handhole enclosures.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground handhole enclosures.

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

1. See Section 016000 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit, or exposed intermediate metal conduit (IMC) is used.
4. Use suitable concrete type boxes where flush-mounted in concrete.
5. Use suitable masonry type boxes where flush-mounted in masonry walls.
6. Use raised covers suitable for the type of wall construction and device configuration where required.
7. Use shallow boxes where required by the type of wall construction.
8. Do not use "through-wall" boxes designed for access from both sides of wall.
9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.

12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
13. Minimum Box Size, Unless Otherwise Indicated:
14. Wall Plates: Comply with Section 262726.
15. Manufacturers:

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
   a. Indoor Clean, Dry Locations: Type 1, painted steel.
   b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
   b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:

D. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 262726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
2. Manufacturer: Same as manufacturer of floor box service fittings.

E. Underground Handhole Enclosures:

1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Applications:
   a. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

1. Locate boxes to be accessible.

I. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.

2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Underground Handhole Enclosures:

1. Install enclosure on gravel base, minimum 6 inches deep.
2. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

N. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078413, 078443, and 079200.

P. Close unused box openings.

Q. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

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

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 260537

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 262726 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

C. Section 271005 - Structured Cabling for Voice and Data: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2007.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2007.

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

D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 - PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Switchboards:
      1) Identify voltage and phase.
      2) Identify power source and circuit number. Include location when not within sight of equipment.
      3) Identify incident energy, arc flash boundary, glove class, limit approach boundary, and restricted approach boundary.
      3) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   b. Motor Control Centers:
      1) Identify voltage and phase.
      2) Use identification nameplate to identify load(s) served for each branch device.

Do not identify spares and spaces.

c. Panelboards:
   1) Identify voltage and phase.
   2) Identify power source and circuit number. Include location when not within sight of equipment.
   3) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
   4) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
d. Transformers:
   1) Identify kVA rating.
   2) Identify voltage and phase for primary and secondary.
e. Enclosed switches, circuit breakers, and motor controllers:
   1) Identify voltage and phase.
   2) Identify load(s) served. Include location when not within sight of equipment.
f. Enclosed Contactors:
   1) Identify ampere rating.
   2) Identify voltage and phase.
   3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
   4) Identify load(s) and associated circuits controlled. Include location.
g. Transfer Switches:
   1) Identify voltage and phase.
   2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
   3) Identify load(s) served. Include location when not within sight of equipment.

2. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
3. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
4. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
   a. Minimum Size: 3.5 by 5 inches.
   b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
5. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
6. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over

600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

7. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
8. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Identification for Communications Conductors and Cables: Comply with Section 271005.
3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
4. Use underground warning tape to identify direct buried cables.

C. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 271005.
2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
3. Use identification label to identify fire alarm system devices.
   a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.

2.2 PRODUCTS

A. Identification Nameplates:

1. Manufacturers:
   a. Brimar Industries, Inc: www.brimar.com.
   b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
   c. Seton Identification Products: www.seton.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:
   a. Brady Corporation: www.bradyid.com.
   b. Brother International Corporation: www.brother-usa.com.
   c. Panduit Corp: www.panduit.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
   a. System designation where applicable:
      1) Fire Alarm System: Identify with text "FIRE ALARM".
   b. Equipment designation or other approved description.
   c. Other information as indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1 inch.
   b. Equipment Designation: 1/2 inch.
   c. Other Information: 1/4 inch.
5. Color:
   a. Normal Power System: White text on black background.
   b. Emergency Power System: White text on red background.
   c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe

operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

G. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

H. Locations:

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

I. Letter Size:

1. Use 1/8 inch letters for identifying individual equipment and loads.
2. Use 1/4 inch letters for identifying grouped equipment and loads.

J. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations.

K. Wire Markers

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

L. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

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

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

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

1. Do not use handwritten text.

P. Minimum Text Height: 1/8 inch.

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

2.3 VOLTAGE MARKERS

2.4 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Brady Corporation; Model: www.bradyid.com.
2. Brimar Industries, Inc: www.brimar.com.
3. Seton Identification Products; Model: www.seton.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:

1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.5 WARNING SIGNS AND LABELS

A. Manufacturers:

1. Brimar Industries, Inc: www.brimar.com.
2. Clarion Safety Systems, LLC: www.clarionsafety.com.
3. Seton Identification Products: www.seton.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:

1. Materials:
   a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive

vinyl signs.
b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester, or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conductors and Cables: Legible from the point of access.
8. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing, or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below

finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors.

B. Outdoor photo controls.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260537 - Boxes.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 262726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, fan speed controllers, and wall plates.

E. Section 265100 - Interior Lighting.

F. Section 265200 – Gymnasium Theatrical Lighting.

1.3 REFERENCE STANDARDS

A. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment - Nonlocking (Button) Type Photocontrols; 2004 (R2010).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

D. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.

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

F. UL 773 - Plug-in Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

G. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

H. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

I. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

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

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:

1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.

D. Field Quality Control Reports.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

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

1. See Section 016000 - Product Requirements, for additional provisions.

H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

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

B. Provide five year manufacturer warranty for all occupancy sensors.

PART 2 - PRODUCTS

2.1 ALL LIGHTING CONTROL DEVICES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

C. Products for Switching of Electronic Fluorescent Ballasts: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.2 OCCUPANCY SENSORS

A. Manufacturers:

1. Hubbell Building Automation, Inc: www.hubbellautomation.com
2. WattStopper: www.wattstopper.com.
3 Leviton: www.leviton.com
4. Acuity
5. Lutron
6. Substitutions: See Section 016000 - Product Requirements.
7. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. All Occupancy Sensors:

1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
2. Sensor Technology:
   a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
   b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
   c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
7. Turn-Off Delay: Field adjustable, up to a maximum time delay setting of not less than 15 minutes and not more than 30 minutes.
8. Sensitivity: Field adjustable.
9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
10. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above the selected level.
11. Compatibility: Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
12. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on the drawings.

13. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

C. Wall Switch Occupancy Sensors:

1. All Wall Switch Occupancy Sensors:
   a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
   b. Unless otherwise indicated or required to control the load indicated on the drawings, provide line voltage units with self-contained relay.
   c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
   d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
   e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:
   a. Description: Low profile occupancy sensors designed for ceiling installation.
   b. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
   c. Provide field selectable setting for disabling LED motion detector visual indicator.
   d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
   e. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
3. Ultrasonic Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 500 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   b. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet.
4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.

E. Power Packs for Low Voltage Occupancy Sensors:
   1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
   2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
   3. Input Supply Voltage: Dual rated for 120/277 V ac.
   4. Load Rating: As required to control the load indicated on the drawings.

2.3 OUTDOOR PHOTO CONTROLS

A. Manufacturers:

   1. Intermatic, Inc: www.intermatic.com.
   2. Paragon, a brand of Invensys Controls: www.invensyscontrols.com.
   3. Tork, a division of NSI Industries LLC: www.tork.com.
   4. Substitutions: See Section 016000 - Product Requirements.
   5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Stem-Mounted Outdoor Photo Controls:

   1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
   2. Housing: Weatherproof, impact resistant polycarbonate.
   3. Photo Sensor: Cadmium sulfide.
   4. Provide external sliding shield for field adjustment of light level activation.
   5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
   6. Voltage: As required to control the load indicated on the drawings.
   7. Failure Mode: Fails to the on position.
   8. Load Rating: As required to control the load indicated on the drawings.
   9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

C. Locking Receptacle-Mounted Outdoor Photo Controls

   1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.
   2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
   3. Photo Sensor: Cadmium sulfide.
   4. Light Level Activation: 1 to 3 footcandles turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
   5. Voltage: As required to control the load indicated on the drawings.
   6. Failure Mode: Fails to the on position.
   7. Load Rating: As required to control the load indicated on the drawings.
   8. Surge Protection: 160 joule metal oxide varistor.

D. Button Type Outdoor Photo Controls

1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of lighting control devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:
   a. Wall Switch Occupancy Sensors: 48 inches above finished floor to the top of the box.

C. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.

G. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

H. Identify lighting control devices in accordance with Section 260553.

I. Occupancy Sensor Locations:

1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

J. Outdoor Photo Control Locations:

1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

L. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

M. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test outdoor photo controls to verify proper operation, including time delays where applicable.

E. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

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

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.

C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

D. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
4. Location: At project site.

END OF SECTION 260923

SECTION 26 0924 – DISTRIBUTED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Distributed Digital Lighting Control System: System includes
   1. Digital Lighting and Plug Load Controls
   2. Relay Panels
   3. Emergency Lighting Control.

1.2 RELATED SECTIONS

A. Section 27 0539 - Surface Raceways for Communications Systems

B. Section 26 5100 – Interior Lighting.

C. Section 23 0993 – HVAC Control Sequence - Integrated Automation, Building integrator shall provide integration of the lighting control system with Building Automation Systems.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. NEMA - National Electrical Manufacturers Association

C. FCC emission standards

D. UL - Underwriters Laboratories, Inc. Listings

E. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces.

F. UL 20 - General Use Switches, Plug Load Controls

G. UL 924 - Standard for Emergency Lighting and Power Equipment

H. ULC - Underwriter Laboratories of Canada Listings

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.

B. System shall conform to requirements of NFPA 70.

C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.

D. System shall be listed under UL sections 916 and/or 508.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 3000 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Catalog sheets and specifications.
   2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   3. Storage and handling requirements and recommendations.
   4. Installation instructions.

C. Shop Drawings: Wiring diagrams a for the various components of the System specified including:
   1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
   2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
   3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
   4. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

E. Closeout Submittals:
   1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
   2. Operation and Maintenance Manual:
      a. Include approved Shop Drawings and Product Data.
      b. Include Sequence of Operation, identifying operation for each room or space.
      c. Include manufacturer's maintenance information.
      d. Operation and Maintenance Data: Include detailed information on device programming and setup.
      e. Include startup and test reports.

F. Title 24 Acceptance Testing Documentation: Submit Certification of Acceptance and associated documentation for lighting control acceptance testing performed in accordance with CAL TITLE 24 P6, as specified in Part 3 of this specification under "COMMISSIONING".

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.

B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.

C. System Components: Demonstrate that individual components have undergone quality control

and testing prior to shipping.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Architect, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.

B. Review installation procedures and coordination required with related Work and the following:
   1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
   2. Review the specifications for low voltage control wiring and termination.
   3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
   4. Discuss requirements for integration with other trades

C. Inspect and make notes of job conditions prior to installation:
   1. Record minutes of the conference and provide copies to all parties present.
   2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
   3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
   2. Relative humidity: Maximum 90 percent, non-condensing.

1.10 WARRANTY

A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

B. Warranty period shall not start until substantial completion of the project.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: WattStopper, which is located at: 2700 Zanker Rd., Suite 168; San Jose, CA 95134; Tel: 408.988.5331; Fax: 408.988.5373; Email:request info (); Web:www.wattstopper.com

B. Substitutions: Hubbell, Acquity NLight, Lutron

C. Requests for substitutions will be considered in accordance with provisions of Section 01 6000 - Product Requirements.

2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

A. System General: Provide a WattStopper Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.
   1. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room.
   2. Daylit Areas: Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code or as indicated on drawings:
      a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
      b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
      c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
      d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
   3. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
   1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
   2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring

capabilities.

3. Digital Fixture Controllers: Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
4. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
5. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
6. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
7. Configuration Tools: Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
8. Digital Lighting Management (DLM) segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.
9. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
10. Wireless Network Bridge and Border Router: Provides Wireless Network Bridges that automatically create BACnet objects for all DLM devices on their local network (room) and communicate that information over a standalone wireless mesh 6LoWPAN network to a Border Router. The Border Router manages the formation and communication of the mesh network, and provides an ethernet network connection to upstream intelligent devices, such as a Segment Manager.
11. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
12. Programming and Configuration Software: Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
13. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.
14. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

C. Local Network LMRJ-Series: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
   1. Features of the DLM local network include:
      a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon

the device attached.

b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.

c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.

d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.

3. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.3 DIGITAL LOAD CONTROLLERS (ROOM AND FIXTURE CONTROLLERS)

A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting control requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
4. Device Status LEDs to indicate:
   a. Data transmission
   b. Device has power
   c. Status for each load
   d. Configuration status
5. Quick installation features including:
   a. Standard junction box mounting
   b. Quick low voltage connections using standard RJ-45 patch cable
6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
   a. Turn on to 100 percent
   b. Turn off
   c. Turn on to last level
7. Each load be configurable to operate in the following sequences based on occupancy:
   a. Auto-on/Auto-off (Follow on and off)

b. Manual-on/Auto-off (Follow off only)

8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.

9. BACnet object information shall be available for the following objects:
   a. Load status
   b. Schedule state, normal or after-hours
   c. Demand Response enable and disable
   d. Room occupancy status
   e. Total room lighting and plug loads watts
   f. Electrical current
   g. Total watts per controller
   h. Total room watts/sq ft.
   i. Force on/off all loads
10. UL 2043 plenum rated
11. Manual override and LED indication for each load
12. Zero cross circuitry for each load
13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
14. Dimming Room Controllers shall share the following features:
   a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
   b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
   c. The following dimming attributes may be changed or selected using a wireless configuration tool:
      1) Establish preset level for each load from 0-100 percent
      2) Set high and low trim for each load
   d. Override button for each load provides the following functions:
      1) Press and release for on/off control
      2) Press and hold for dimming control
   e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
   f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
   g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
   h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

B. On/Off Room Controllers shall include:
   1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load

2. One or two relay configuration
3. Simple 150 mA switching power supply (Only 4 100 series devices on a Cat 5e local network)
4. Three RJ-45 DLM local network ports with integral strain relief and dust cover
5. WattStopper product numbers: LMRC-101, LMRC-102

C. On/Off/0-10V Dimming Enhanced Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
2. Built in real time current monitoring
3. One, two or three relays configurations
4. Smart 250 mA switching power supply
5. Four RJ-45 DLM local network ports. Provide integral strain relief
6. One dimming output per relay
    a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting (LMRC-110 series and 210 series).
7. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213.

D. On/Off/ Forward Phase Dimming Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) rated for 20A total load, with forward phase dimmed loads derating to 16A for some load types
2. Built in real time current monitoring
3. One or two relays configurations
4. Smart 250 mA switching power supply
5. Four RJ-45 DLM local network ports. Provide integral strain relief
6. One dimming output per relay
    a. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-220 series)
7. WattStopper product numbers: LMRC-221, LMRC-222

E. Fixture Controllers shall include
1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
2. One 3A 120/277V rated mechanically held relay.
3. Programmable behavior on power up following the loss of normal power:
    a. Turn on to 100 percent
    b. Turn off
    c. Turn on to last level
4. Requirement for 7 mA of 24VDC operating power from the DLM local network.
5. Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the DLM local network to drive accessory devices.
6. Power to drive the LMFC Fixture Controller electronics can come from any Room or Plug Load Controller, LMPB-100 Power Booster and/or LMZC-301 Zone Controller
7. 0-10V dimming capability via a single 0-10 volt analog output from the device for

control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.

8. Connect to a single or dual RJ-45 adaptor with 24 inch leads. Single adaptor mounts in a 1/2 inch KO and dual adaptor in a 2.2 by 1.32 inch rectangular hole for connection to the DLM local network.
9. Adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.
10. A complete set of dimming features described above in the paragraph detailing On/Off/Dimming Enhanced Room Controllers.
    a. WattStopper product numbers: Fixture Controller: LMFC-011, DLM Cable Connector: LMFC-RJ-50-24 or LMFC-2RJ, Power Booster: LMPB-100.

2.4 DIGITAL WALL OR CEILING MOUNTED WIRELESS OCCUPANCY SENSOR

A. Digital Occupancy Sensors shall provide digital calibration and electronic documentation. Features include the following:
   1. Digital calibration for the following variables:
      a. Sensitivity, 0-100 percent in 10 percent increments
      b. Time delay, 1-30 minutes in 1 minute increments
      c. Test mode, Five second time delay
      d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
      e. Walk-through mode
   2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
   3. Programmable control functionality including:
      a. Each sensor may be programmed to control specific loads within a local network.
      b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
      c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
      d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
      e. Ultrasonic and Passive Infrared
      f. Ultrasonic or Passive Infrared
      g. Ultrasonic only
      h. Passive Infrared only
      i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
   4. Wireless connection to DLM local network.
   5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
   6. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
   7. Manual override of controlled loads.
   8. All digital parameter data programmed into an individual occupancy sensor shall be

retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

9. Operation on an included CR123A battery providing a 10+ year lifespan.

B. BACnet object information shall be available for the following objects:
   1. Detection state
   2. Occupancy sensor time delay
   3. Occupancy sensor sensitivity, PIR and Ultrasonic

C. Units shall not have any dip switches or potentiometers for field settings

D. WattStopper product numbers: LMPX,LMPC

2.5 DIGITAL WALL SWITCH OCCUPANCY SENSORS

A. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton configuration for the following variables:
      a. Sensitivity: 0-100 percent in 10 percent increments
      b. Time delay: 1-30 minutes in 1 minute increments
      c. Test mode: Five second time delay
      d. Detection technology: PIR, Dual Technology activation and/or re-activation.
      e. Walk-through mode
      f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
   2. Programmable control functionality including:
      a. Each sensor may be programmed to control specific loads within a local network.
      b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
      c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
      d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
         1) Ultrasonic and Passive Infrared
         2) Ultrasonic or Passive Infrared
         3) Ultrasonic only
         4) Passive Infrared only
   3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
   4. Two RJ-45 ports for connection to DLM local network.
   5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
   6. Device Status LEDs including
      a. PIR detection
      b. Ultrasonic detection
      c. Configuration mode
      d. Load binding
   7. Assignment of any occupancy sensor to a specific load within the room without wiring or

special tools.

8. Assignment of local buttons to specific loads within the room without wiring or special tools
9. Manual override of controlled loads
10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
1. Detection state
2. Occupancy sensor time delay
3. Occupancy sensor sensitivity, PIR and Ultrasonic
4. Button state
5. Switch lock control
6. Switch lock status

C. Units shall not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
1. Left button
   a. Press and release - Turn load on
   b. Press and hold - Raise dimming load
2. Right button
   a. Press and release - Turn load off
   b. Press and hold - Lower dimming load

F. Low voltage momentary pushbuttons shall include the following features:
1. Load/Scene Status LED on each switch button with the following characteristics:
   a. Bi-level LED
   b. Dim locator level indicates power to switch
   c. Bright status level indicates that load or scene is active
2. The following button attributes may be changed or selected using a wireless configuration tool:
   a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
   b. Individual button function may be configured to Toggle, On only or Off only.
   c. Individual scenes may be locked to prevent unauthorized change.
   d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
   e. Ramp rate may be adjusted for each dimmer switch.
   f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
   g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.6 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
   1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
   2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
   3. Configuration LED on each switch that blinks to indicate data transmission.
   4. Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED
      b. Dim locator level indicates power to switch
      c. Bright status level indicates that load or scene is active
      d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
   5. Programmable control functionality including:
      a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
      b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
   6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Button state
   2. Switch lock control
   3. Switch lock status

C. Two RJ-45 ports for connection to DLM local network.

D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
   1. Individual button function may be configured to Toggle, On only or Off only.
   2. Individual scenes may be locked to prevent unauthorized change.
   3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
   4. Ramp rate may be adjusted for each dimmer switch.
   5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
   6. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.7 DIGITAL DAYLIGHTING SENSORS

A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.

1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone

B. Digital daylighting sensors shall include the following features:
1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
10. Configuration LED status light on device that blinks to indicate data transmission.
11. Status LED indicates test mode, override mode and load binding.
12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
    a. Light level
    b. Day and night setpoints
    c. Off time delay
    d. On and off setpoints
    e. Up to three zone setpoints

f. Operating mode - on/off, bi-level, tri-level or dimming

14. One RJ-45 port for connection to DLM local network.
15. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.
16. Any load or group of loads in the room can be assigned to a daylighting zone
17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

C. Closed loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
4. WattStopper Product Number: LMLS-400, LMLS-400-L.

D. Open loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
4. WattStopper Product Number: LMLS-500, LMLS-500-L.

E. Dual loop digital photosensors shall include the following additional features:
1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this con
2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.

4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
6. Device must include extendable mounting arm to properly position sensor within a skylight well.
7. WattStopper product number LMLS-600

2.8 DIGITAL PARTITION CONTROLS

A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.

B. Four-button low voltage pushbutton switch for manual control.
1. Two-way infrared (IR) transceiver for use with configuration remote control.
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Configuration LED on each switch that blinks to indicate data transmission.
4. Each button represents one wall; Green button LED indicates status.
5. Two RJ-45 ports for connection to DLM local network.
6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.

C. Coordinate contact closure interface for automatic control via input from limit switches on movable walls specified in Section 10 22 43 - Sliding Partitions .
1. Operates on Class 2 power supplied by DLM local network.
2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
3. Input max. sink/source current: 1-5mA
4. Logic input signal voltage High: > 18VDC
5. Logic input signal voltage Low: < 2VDC
6. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
7. Two RJ-45 ports for connection to DLM local network.
8. WattStopper part number: LMIO-102

2.9 HANDHELD CONFIGURATION TOOLS

A. Provide a wireless configuration tool to facilitate customization of DLM local networks using two-way infrared communications, and/or PC software that connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include but not be limited to:
1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.

2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.
4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
8. Verify status of building level network devices.

C. WattStopper Product Numbers: Handheld LMCT-100

2.10 DLM SEGMENT NETWORK

A. Provide a segment network using linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
3. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
4. Network wire jacket is available in high visibility green, white, or black.
5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
6. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
7. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an NB-ROUTER or LMSM Unit. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable

B. WattStopper Product Number: LM-MSTP, LM-MSTP-W, LM-MSTP-B, LM-MSTP-DB

2.11 NETWORK BRIDGE

A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.

1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

3. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
   a. Read/write the normal or after hours schedule state for the room
   b. Read the detection state of each occupancy sensor
   c. Read the aggregate occupancy state of the room
   d. Read/write the On/Off state of loads
   e. Read/write the dimmed light level of loads
   f. Read the button states of switches
   g. Read total current in amps, and total power in watts through the load controller
   h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
   i. Activate a preset scene for the room
   j. Read/write daylight sensor fade time and day and night setpoints
   k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
   l. Set daylight sensor operating mode
   m. Read/write wall switch lock status
   n. Read watts per square foot for the entire controlled room
   o. Write maximum light level per load for demand response mode
   p. Read/write activation of demand response mode for the room
   q. Activate/restore demand response mode for the room

B. WattStopper product numbers: LMBC-300

2.12 WIRELESS NETWORK BRIDGES AND BORDER ROUTER

A. Wireless Network Bridges connect to a DLM local network (room) and use IEEE 802.15.4 6LoWPAN for communication between rooms and to a Border Router that oversees the formation and configuration of the wireless network. Each local network shall include a wireless network bridge that connects to the other DLM devices on the local network, and a group of Wireless Bridges shall connect to a Border Router.

B. Features of the Wireless Network Bridges shall be as follows:
   1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
   2. Wireless Bridges provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the Border

Router via the wireless network. No commissioning shall be required for set up of the network bridge on the local network.

3. Wireless Bridges shall incorporate dual internal omni-directional antennas with diversity to provide wide and robust communication, and so the antennas will be protected against accidental contact with other objects in the space.

4. Two LEDs shall be included on the bridge to provide feedback about the local network (red) and wireless network (blue) health.
5. Wireless Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID per room are not acceptable. Standard BACnet objects shall be provided as follows:
    a. Read/write the normal or after hours schedule state for the room
    b. Read the detection state of each occupancy sensor
    c. Read the aggregate occupancy state of the room
    d. Read/write the On/Off state of loads
    e. Read/write the dimmed light level of loads
    f. Read the button states of switches
    g. Read total current in amps, and total power in watts through the load controller
    h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
    i. Activate a preset scene for the room
    j. Read/write daylight sensor fade time and day and night setpoints
    k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
    l. Set daylight sensor operating mode
    m. Read/write wall switch lock status
    n. Read watts per square foot for the entire controlled room
    o. Write maximum light level per load for demand response mode
    p. Read/write activation of demand response mode for the room
    q. Activate/restore demand response mode for the room

C. Features of the Wireless Border Router shall be:
1. The Wireless Border Router shall manage the formation and configuration of the 6LoWPAN wireless mesh network, and provide connectivity via wired 10/100 Ethernet to a local area network that may include a LMSM Segment Manager or Building BAS System.
2. Border Router shall provide key information about the health of the mesh network in the form of signal quality, device status, network status, and other real-time network information such as energy monitoring.
3. The LMBR-600 shall have dual internal omni-directional antennas with diversity to ensure reliable communication with Wireless Network Bridges, and provide a user interface for set up and configuration.
4. Include an internal MicroSD card and a Real-time clock with supercap back-up. Border Router shall get power for operation via a 120V outlet (in non-plenum applications) and a dedicated DLM LMPB-100 Power Booster connected to a Cat 5e to DC barrel connector

(for plenum applications)

D. Communication between the Wireless Network Bridges and the Border Router
   1. The communication between the Wireless Bridges and the Border Router shall be via a standalone wireless mesh network that does not require interface with any other wireless network in the space. The mesh network shall allow communication between all rooms as long as they are within 100' of another connected room.
   2. The Wireless Bridges shall communicate over a 6LoWPAN 2.4 GHz IEEE 802.15.4 network and use AES 128 bit Key Encryption for network security.
   3. In addition to IEEE IPV6, the Border Router shall have available Constrained Application Protocol (CoAP), Routing Protocol for Low Power Networks (RPL), and Stateless Multicast RPL Forwarding (SMRF).
   4. The wireless protocol shall allow BACnet communication to be transported transparently between the Network Bridge and any front end BAS devices such as the LMSM Segment Manager.

E. WattStopper product numbers: Wireless Network Bridge LMBC-600, Wireless Border Router LMBR-600.

2.13 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

A. Hardware: Provide LMCP lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:

   1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
   2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
   3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
      a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
      b. Individual terminal block, override pushbutton, and LED status light for each relay.
      c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
      d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate

digital networks, each capable of supplying 250mA to connected devices.

e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.

f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.

h. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.

4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
   a. Electrical:
      1) 30 amp ballast at 277V
      2) 20 amp ballast at 347V
      3) 20amp tungsten at 120V
      4) 30 amp resistive at 347V
      5) 1.5 HP motor at 120V
      6) 14,000 amp short circuit current rating (SCCR) at 347V
      7) Relays shall be specifically UL 20 listed for control of plug-loads
   b. Mechanical:
      1) Replaceable, 1/2 inch KO mounting with removable Class 2 wire harness.
      2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
      3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
      4) Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
   a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 tnetworked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
   b. Clock capability of each panel shall support the time-based energy saving

requirements of applicable local energy codes.

c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.

d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
   1) Scheduled ON / OFF
   2) Manual ON / Scheduled OFF
   3) Astro ON / OFF (or Photo ON / OFF)
   4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)

e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)

f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.

g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.

9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.

10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.

a. Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

b. Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.

c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.

d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.

e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.

f. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming

remote. Provide BACnet objects for panel setup and control as follows:

1) Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
2) Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
3) Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
4) Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.

g. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
h. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)
i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
j. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
    a. Use the same intelligence board as the LMCP relay panel.
    b. Shall not include relay driver boards or relays.
    c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
    d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
    e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50 percent output when any digital occupancy sensor detects motion.
13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone Controller: LMZC-301.

B. User Interface: Each lighting control panel system shall be supplied with at least one handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall

allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. User interface shall have the following panel-specific functions as a minimum:

1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
7. WattStopper Product Number: LMCT-100

2.14 SEGMENT MANAGER

A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).

B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.

C. Operational features of the Segment Manager shall include the following:
   1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
   2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
   3. Log in security capable of restricting some users to view-only or other limited operations.
   4. Segment Manager shall provide two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to

dynamic monitor the performance of their system, and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:

a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.

b. Allow information for all discovered DLM devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager

c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.

d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.

e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.

5. Capabilities using the Segment Manager's Dashboard Screens shall include:

a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers such as LMRC-21x).Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.

b. Ability to set up schedules for DLM local networks (rooms) and panels.

Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.

c. For fixtures that are accessible via the Segment Network, and have CCT capability as specified under paragraph Digital Wall Switch and Timer For Correlated Color Temperature, the Segment Manager will provide schedule functionality similar to the CCT Wall Timer, allowing all CCT fixtures across the entire facility to be scheduled together.

d. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).

6. If shown on the Drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.

7. Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

D. Segment Manager v2.2 and later shall support multiple DLM rooms as follows:
1. Support up to 120 network bridges and 750 digital in-room devices (LMSM-3E).
2. Support up to 200 network bridges and 1,100 digital in room devices, connected via network routers and switches (LMSM-6E).

E. WattStopper Product Numbers: LMSM-3E, LMSM-6E, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.15 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.

B. Additional parameters exposed through this method include but are not limited to:
1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow

Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
6. Load control polarity reversal so that on events turn loads off and vice versa.
7. Per-load DR (demand response) shed level in units of percent.
8. Load output pulse mode in increments of 1second.
9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.

C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
1. Device list report: All devices in a project listed by type.
2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
5. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
7. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.

D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
1. Set, copy/paste an entire project site of sensor time delays.
2. Set, copy/paste an entire project site of sensor sensitivity settings.
3. Search based on room name and text labels.
4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.
5. Filter by parameter value to search for product with specific configurations.

E. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
2. Mass firmware update of specifically selected rooms or areas.
3. Mass firmware upgrade of specific products

F. WattStopper Product Number: LMCS-100, LMCI-100

2.16 EMERGENCY LIGHTING CONTROL DEVICES

A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
2. Push to test button
3. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 EXECUTION

3.1 PREPARATION

A. Do not begin installation until measurements have been verified and work areas have been properly prepared.

B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

3.2 INSTALLATION

A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.

B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
2. If fixtures have internal DLM Control Modules, ensure that they are also connected with Cat 5e cable.
3. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire or wireless devices. Network wire substitution is not permitted and may result in loss of product warranty.
4. Low voltage wiring topology must comply with manufacturer's specifications.
5. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

C. All line voltage connections shall be tagged to indicate circuit and switched legs.

D. Test all devices to ensure proper communication.

E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
3. Load Parameters (e.g. blink warning, etc.)

G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.

H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.

I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.

L. Remote Access for Network Systems: Ensure Segment Manager enclosure is installed in a location with good to excellent cellular phone coverage based on building orientation and geographic location, and mount magnetic antenna for the modem. For cases where alternate mounting locations are not available and a stronger cellular signal is needed, the manufacturer shall offer additional antenna options to improve signal quality. Verify final mounting location with Engineer and Owner prior to proceeding with the Work.

M. Provide integration to Building Management System.

N. Provide system start-up after completion of each phase of construction.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.

B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
   1. Verify Class I and II wiring connections are terminated properly by validating system performance.
   2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
   3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
   4. Verify that the control of each space complies with the Sequence of Operation.
   5. Correct any system issues and retest.

C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
   1. Date of test or inspection.
   2. Loads per space, or Fixture Address identification.
   3. Quantity and Type of each device installed

4. Reports providing each device's settings.

3.4 COMMISSIONING ASSISTANCE

A. Title 24 Acceptance Testing Service; Include additional costs for Lighting Control Manufacturer to provide a technician for one additional day while the CLCATT performs lighting control acceptance testing in accordance with CAL TITLE 24 P6 including submission of required documentation.

3.5 DEMONSTRATION AND TRAINING

A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:
   1. Confirmation of entire system operation and communication to each device.
   2. Confirmation of operation of individual relays, switches, and sensors.
   3. Confirmation of system Programming, photocell settings, override settings, etc.
   4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

3.6 PRODUCT SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION 26 0924

SECTION 262413- SWITCHBOARDS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Switchboard.

B. Switchboard accessories.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for supporting foundations and pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 264300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. NECA 400 - Standard for Installing and Maintaining Switchboards (ANSI); National Electrical Contractors Association; 2007.

B. NEMA PB 2 - Deadfront Distribution Switchboards; National Electrical Manufacturers Association; 2011.

C. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007

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

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

1.4 SUBMITTALS

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

B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.

C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.

D. Test Reports: Indicate results of factory production tests.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Project Record Documents: Record actual locations of switchboards.

G. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

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

1. See Section 016000 - Product Requirements, for additional provisions.
2. Enclosure Keys: Two of each different key.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Extend existing General Electric Switchboard

2.2 SWITCHBOARDS

A. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.

B. Ratings:

1. Voltage: 120/208 volts.
2. Configuration: Three phase, four wire, grounded.
3. Main Bus: See drawings.
4. Integrated Equipment Rating: 65,000 rms amperes symmetrical.

C. Main Section Devices: Individually mounted and compartmented.

D. Distribution Section Devices: Panel mounted.

E. Bus Material: Existing.

F. Bus Connections: Bolted, accessible from front for maintenance.

G. Fully insulate load side bus bars in rear accessible compartments. Do not reduce spacing of insulated bus.

H. Ground Bus: Extend length of switchboard.

I. Solid-State Molded Case Circuit Breakers: With electronic sensing, timing and tripping circuits for adjustable current settings; UL listed.

1. Ground fault trip, ground fault sensing integral with circuit breaker.
2. Instantaneous trip.
3. Adjustable short time trip.
4. Stationary mounting.
5. Include shunt trip where indicated.

J. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.

K. Ground Fault Sensor: Zero sequence type.

L. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay.1 to.5 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

M. Pull Section:

1. Arrange as shown on Drawings.

N. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

O. Enclosure: Type 1 - General Purpose.

1. Align sections at front only.
2. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.
3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
4. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard.

a. Use plastic strips.
b. Fasten strips flat against the panel face with screws or rivets.

P. Switchboard Sections.

1. Provide solid barriers between each switchboard section.

2.3 SURGE PROTECTIVE DEVICES

A. See Section 264300 for factory-installed, internally mounted surge protective devices. List and label switchboards containing surge protective devices as a complete assembly including surge protective device.

2.4 AMMETERS AND VOLTMETERS

A. Existing

2.5 SOURCE QUALITY CONTROL

A. Shop inspect and test switchboard according to NEMA PB 2.

PART 3 - EXECUTION

3.1 PREPARATION

A. Extend existing concrete housekeeping pad under the provisions of Section 033000.

B. Verify that field measurements are as indicated on shop drawings.

3.2 INSTALLATION

A. Install switchboard in locations shown on drawings, according to NEMA PB 2.1.

B. Install in a neat and workmanlike manner, as specified in NECA 400.

C. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

D. Identify switchboards in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 014000.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.4 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trips and time delays in accordance with Selective Coordination Study.

3.5 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260529 - Hangers and Supports for Electrical Systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).

F. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.

H. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

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

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

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

L. UL 67 - Panelboards; Current Edition, Including All Revisions.

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

N. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

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

1. See Section 016000 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric; Square D Products: www.schneider-electric.us.

B. General Electric Company: www.geindustrial.com

C. Siemens: www.siemens.com

D. Bussman: www.bussman.com

E. Eaton: www.eaton.com

F. Substitutions: See Section 016000 - Product Requirements.

G. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ALL PANELBOARDS

A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
2. Ambient Temperature:
   a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
3. Label equipment utilizing series ratings as required by NFPA 70.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 3R.

2. Boxes: Galvanized steel unless otherwise indicated.
   a. Provide wiring gutters sized to accommodate the conductors to be installed.
   b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
   c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

L. Load centers are not acceptable.

M. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

D. Circuit Breakers:
1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
2. Provide thermal magnetic circuit breakers unless otherwise indicated.
3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
      2) 14,000 rms symmetrical amperes at 480 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Provide compression lugs where indicated.
   c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
6. Provide the following circuit breaker types where indicated:
7. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.
10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
11. Provide the following features and accessories where indicated or where required to complete installation:
    a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2.6 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

2.7 COORDINATION PANELBOARDS

A. Bussman Quick-Spec Paanelboards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 260529.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

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

1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

J. Install all field-installed branch devices, components, and accessories.

K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

L. Set field-adjustable circuit breaker tripping function settings as indicated.

M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

N. Provide filler plates to cover unused spaces in panelboards.

O. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:

P. Identify panelboards in accordance with Section 260553.

Q. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.

3.3 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.

B. Perform field inspection and testing in accordance with Section 014000.

C. Inspect and test in accordance with NETA STD ATS, except Section 4.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 225 amperes. Tests listed as optional are not required.

E. Test shunt trips to verify proper operation.

F. Correct deficiencies and replace damaged or defective panelboards or associated components.

G. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Wall switches.

B. Wall dimmers.

C. Receptacles.

D. Wall plates.

E. Floor box service fittings.

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

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: As selected by the architect.

2.4 WALL SWITCHES

A. Manufacturers:

B. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Commercial Specification Grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.5 WALL DIMMERS

A. All Wall Dimmers: Commercial Specification Grade, Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

B. Wall Dimmers: Semiconductor dimmer for incandescent lamps, Type as indicated on drawings, complying with NEMA WD 6 and WD 1.

2.6 RECEPTACLES

A. Manufacturers:

B. All Receptacles: Commercial Specification Grade, self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:

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.

2.7 WALL PLATES

A. Manufacturers:

B. All Wall Plates: Comply with UL 514D. Commercial Specification Grade, Stainless Steel.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard and Oversized as required.
3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

D. Weatherproof 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.

2.8 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:

B. Description: Service fittings compatible with floor boxes provided under Section 260537 with all components, adapters, and trims required for complete installation.

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

SECTION 264300 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

B. Surge protective devices for distribution locations.

C. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 262413 - Switchboards.

C. Section 262416 - Panelboards.

D. Section 271000 - Structured Cabling: Protectors for communications service entrance.

1.3 ABBREVIATIONS AND ACRONYMS

A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.

B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

A. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2014).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

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

F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.6 SUBMITTALS

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

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:

1. UL 1449.
2. UL 1283 (for Type 2 SPDs).

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

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

B. Manufacturer's Warranty: Provide minimum ten year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Schneider Electric

B. Field-installed, Externally Mounted Surge Protective Devices - Other Acceptable Manufacturers:

1. Advanced Protection Technologies (APT)
2. ASCO Power Technologies
3. Leviton
4. Surge Suppression Incorporated (SSI)

C. Factory-installed, Internally Mounted Surge Protective Devices:

1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

D. Substitutions: See Section 016000 - Product Requirements.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:

1. Wye Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):

1. 208Y/120V System Voltage: Not more than 800V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
2. 480Y/277V System Voltage: Not more than 1,200 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

1. Indoor clean, dry locations: NEMA Type 1.
2. Outdoor locations: NEMA Type 3R.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:

1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.

1. Switchgear: See Section 262300.
2. Switchboards: See Section 262413.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
   (EMA Series) Model: SSPxxEMA24
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
6. Diagnostics:
   a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
   d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.4 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards, motor control centers, and busway.

B. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
   (EMA Series) Model: SSPxxEMA16
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
   a. Noise Attenuation: Not less than -50 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
   a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
   d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.5 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 50 kA per mode/100 kA per phase.
   (XDSE Series) Model: SSPxxXDSE10A
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
   a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

6. Diagnostics:
   a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 260526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

C. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 260526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

G. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Section 7.19.1.

D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.4 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 264300

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Interior luminaires.

B. Lamps.

C. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 260537 - Boxes.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 260923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.

D. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.

E. Section 265200 – Gymnasium Theatrical Lighting.

1.3 REFERENCE STANDARDS

A. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type); 2002.

B. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; Consolidated-2002.

C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (R2008).

D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002.

E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.

F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.

H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2006.

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

J. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.

K. UL 1029 - High-Intensity-Discharge Lamp Ballasts; Current Edition, Including All Revisions.

L. UL 1598 - Luminaires; Current Edition, Including All Revisions.

M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

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

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
2. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.

D. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.

E. Field Quality Control Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

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

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type. Exclude LED lamps from this section.
3. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type. Do not include LED Drivers.

I. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 70 and NFPA 101.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

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

B. Provide two year manufacturer warranty for all linear fluorescent ballasts.

C. Provide five year pro-rata warranty for batteries for emergency lighting units.

D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

B. Substitutions: See Section 016000 - Product Requirements.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires: Listed and labeled as complying with UL 8750.

1. Provide lumen output and color temperature as indicated on the Luminaire schedule.
2. Provide LED driver as indicated on the Luminaire schedule. Provide 0-10v dimming driver where required.
3. LED Luminaires shall be warranted for a minimum of 10 years.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Ceiling Mounted Luminaires:

1. Do not use ceiling tiles to bear weight of luminaires.
2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members, or to building structure.
4. Secure pendant-mounted luminaires to building structure.
5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

F. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.
5. Unless otherwise indicated, support pendants from swivel hangers.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior luminaires.

B. Poles and accessories.

1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0537 - Boxes.

E. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including outdoor motion sensors, time switches, and outdoor photo controls.

F. Section 26 2726 - Wiring Devices: Receptacles for installation in poles.

1.3 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; 2017.

B. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).

C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.

D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.

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

H. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
   2. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

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

B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Provide photometric calculations where luminaires are proposed for substitution upon request.
   3. Provide structural calculations for each pole proposed for substitution.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.
      b. Include IES LM-79 test report upon request.

D. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.

E. Field Quality Control Reports.
   1. Include test report indicating measured illumination levels.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

H. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide three year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires in accordance with NECA/IESNA 501.

E. Provide required support and attachment in accordance with Section 26 0529.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Install accessories furnished with each luminaire.

H. Bond products and metal accessories to branch circuit equipment grounding conductor.

I. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

E. Measure illumination levels at night with calibrated meters to verify compliance with performance requirements. Record test results in written report to be included with submittals.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

3.6 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

3.9 ATTACHMENTS

A. Luminaire schedule.

END OF SECTION 265600

SECTION 26 6000 – THEATRICAL LIGHTING SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. The Electrical Contractor, as part of this section, shall provide, install and test a theatrical lighting system as specified herein for areas indicated on the drawings.

B. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the theatrical lighting system.

C. The Electrical Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to:

1. General conditions

2. Electrical section general provisions

3. Conduit

4. Wire and Cable

D. The systems shall be designed for the control of theatrical lighting systems and shall consist of factory pre-wired dimming, rack enclosures, power supplies, breakers, terminals and/or control electronics and electric hoist system.

1.2 SUBMITTALS

A. Manufacturer shall provide shop drawing submittals. Refer to Division 1 for quantity of submittals and shop drawings. Submittals shall include:

1. Manufacturer shall provide shop drawing submittals. Refer to Division 1 for quantity of submittals and shop drawings. Submittals shall include:

2. Full set of printed technical data sheets.

3. Detailed set of schedules.

4. Detailed set of circuit and control schedules, including a complete list of all deviations from the specifications.

B. Product data for video equipment, lighting fixtures, lamps, distribution components, and control systems, including dimensions and data on features and components. Include data on ratings and features of devices.

C. Manufacturer Certificates: Signed by manufacturers certifying that they comply with the requirements. Include evidence of manufacturing experience.

D. Field test reports: Indicate and interpret test results for compliance with performance requirements.

E. Manufacturer shall provide and additional information, including equipment demonstration, as required by the Engineer to verify compliance with the specifications.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" for components and installation.

B. Installer Qualifications: An experienced installer who has installed systems of similar scope and function as the required for this project.

C. Manufacturer shall be one who has been continuously engaged in the manufacturing of lighting control equipment for a minimum of ten years.

D. Proposed equipment shall be UL and C-UL listed, and/or CE marked (where applicable) and bear the appropriate labels.

E. All dimmers, enclosures, controls, and fixtures shall be manufactured in the United States. Equipment manufactured outside of the United States will not be accepted.

1.4 QUALIFICATIONS OF BIDDERS

A. The bidder shall be a firm with a minimum of 5 years of experience in the fabrication, assembly, and installation of theatrical lighting systems of similar magnitude and quality as specified in these documents, and shall submit documentation to this effect with the bid return.

B. The bidder shall be I.C.I.A / A.V.S.P certified.

1.5 ALTERNATE EQUIPMENT

A. This equipment was selected to establish a standard of quality and performance. The contractor may offer substitutes for approval but the burden of proof of equality shall be with the contractor.

B. Pre-approval submittals shall contain a component-by-component comparison of all specification lines. Differences shall be clearly highlighted with the explanation and support data. Connection drawings shall also be provided to establish how the substituted components will achieve the specified system design

C. The contractor shall provide any additional documentation, samples, or performance tests required by the Engineer in order to establish proof of equality with the specified equipment.

D. All substitutions shall provide equal or greater system performance and function. No substitute equipment shall be purchased or installed without approval by the Engineer.

E. Final approval of the substituted equipment shall be given after the system has been installed. Failure to meet the specification, as determined by the Engineer, shall result in the removal of the substituted equipment and the installation of the specified equipment without any additional cost to the owner.

1.5 EXCEPTIONS

A. Any and all exceptions to these specifications and related drawings must be made with the submission of the bid. In the absence of exceptions, the specifications and related drawings shall be binding in letter and intent on the successful bidder. It will also be understood that the bidder has examined the design and specifications in detail, and is prepared to take full responsibility for the performance of the complete installation as designed and specified.

1.6 SUB-CONTRACT INFORMATION

A. Any and all sub-contractors that a bidder plans to utilize for this project are to be listed with the references and qualifications in the bid submission. The successful bidder shall supervise all sub-contract work. Any and all sub-contract work is the complete and sole responsibility of the contractor.

1.7 SPECIFICATION INFORMATION REQUESTS AND QUESTIONS

A. Any requests for clarification shall be submitted to Mr. DJ Seibert of Snyder Hoffman Associates, 1005 West Lehigh Street, Bethlehem, PA, 18018, 610-694-8020, dseibert@snyderhoffman.com. All requests are to be made in writing and submitted no later than ten days prior to bid submission.

1.8 CERTIFICATIONS AND REPRESENTATIONS

A. Quality of materials: All equipment items and installation materials will be new. No previously owned, demonstrated or otherwise used items will be provided. Note that prior to equipment installation and on-site integration, all equipment items shall be performance tested and quality checked to insure full functionality of each equipment item.

B. Tax Statement Certification: The contractor certifies that all local, state, and federal taxes are separately listed in any price quotations.

1.9 ACCEPTABLE MANUFACTURERS

A. The lighting equipment shall be manufactured by:

1. Electronic Theater Controls
   630 9th Ave Suite 1001
   New York, NY 10036
   Phone: 1-212-397-8080
   Fax: 1-212-397-4340
   Web: www.etcconnect.com

B. Alternative Manufacturers: Subject to compliance with requirements, manufactures offering products that may be incorporated into the work include, but not limited to, the following:

1. Lehigh Electric Products Company
   6265 Hamilton Blvd
   Allentown, PA 18106
   Phone: 610-395-3386
   Fax: 610-395-7735
   Web: www.lehighdim.com

2. Altman Lighting, Inc.
   57 Alexander Street
   Yonkers, NY 10701
   Phone: 914-476-7987
   Fax: 914-963-7304
   Web: www.altmanltg.com

3. Strand Lighting, Inc.
   928 Broadway, Suite 1010
   New York, NY 10010

Phone: 212-242-1042
Fax: 212-242-1837
Web: www.strandlighting.com

C. Permission to bid does not imply acceptance of the manufacturer. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for control systems that meet or exceed the specifications.

D. Other manufacturers wishing to be considered for prior approval must submit the following items prior to the bid date. Approval to bid does not waive the requirement to comply with the equipment specifications listed in this section.

1. A complete bill of material listing all proposed equipment.

2. Catalog sheets detailing the products proposed in 1 above.

3. Description listing any deviations the proposed substitution has as compared with the specified system.

4. Detail additional costs associated with using the alternate system in lieu of the specified system.

E. Alternative manufacturers must submit a full pre-approval package no later than ten days prior to bid date.

F. Permission to bid does not imply acceptance of the manufacturer. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for control systems that meet or exceed the specifications.

G. The manufacturer's latest published equipment specifications shall be considered as part of this text.

PART 2 PRODUCTS

2.1 FIXTURES AND DISTRIBUTION EQUIPMENT, GENERAL

A. Metal Parts: Free from burrs and sharp corners and edges.

B. Sheet metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Fixture doors and other internal access: Smooth operating, free from light leakage, and arranged to permit relamping without the use of tools. Arrange doors, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when in operating position.

D. Pigtail: Factory wired, 36 inch (900mm) long, 3-wired cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.

E. Plug Connectors: Two-pole, 3 wire, 20A Edison type.

F. Safety Cables: Heavy duty, flexible steel, 30 inch nominal length, with spring clip at one end and steel ring at other.

G. Pipe Clamps: Malleable iron, suitable for clamping fixtures or items to pipe from 3/4" to 2 inch in outside diameter. Arrange fixture clamps for horizontal rotation of yoke for aiming and equipped with a T-bolt to lock alignment.

H. Fixture Operating Controls and Handles: Thermally Insulated.

I. Fixture Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

2.2 INTELLIGENT BREAKER SYSTEM

A. General

1. Intelligent breaker system shall be 120V Sensor IQ as manufactured by ETC, Inc., or equal

2. Breaker Panels shall be UL508, UL67, and UL924 Listed, and shall be so labeled when delivered

3. Breakers shall be UL489 listed and shall be labeled when delivered

4. Breaker Panels shall consist of a main enclosure with 12, 24, or 48 pole breaker subpanels, integral control electronics for low voltage terminations and provision for accessory cards

    a. Up to two accessory cards shall be supported per breaker panel

B. Mechanical

1. The panel shall be constructed of 16-gauge galvannealed steel. All panel components shall be properly treated or finished in fine-textured, scratch resistant paint

2. Breaker panels shall be capable of being mounted on the surface of a wall or recessed mounted

3. Breaker panels shall be available in 12, 24, and 48 pole configurations.

4. Choice of panel covers shall be available for surface or recess mount applications. This outer panel shall ship complete with a locking door to limit access to electronics and breakers

    a. Optional center-pin reject security screws shall be available for all accessible screws

    b. Optional recess mount doors shall extend 1” beyond all panel edges to hide wall cut-out

5. The unit shall provide interior cover over the control electronics and accessory cards to allow access only to class 2 wiring and prevent direct access to class 1 line voltage components

6. The panel shall support up to twelve, twenty-four, or 48 single pole branch circuits

    a. Branch circuits shall range from 15A to 30A capable of holding full rated load for minimum of three hours continuously

    b. Two and three-pole circuits shall be supported at decreased density where each pole constitutes one of the available single-pole circuits. Mixing of circuits in any combination shall be supported

7. Breakers shall provide manual switching control while power is unavailable to the panel such that critical lighting can be set to an on state, without the need for power to the panel

8. Breaker output lugs shall accept 10-14 AWG dual conductor wire

9. Breaker output lug shall support solid or stranded 6-14 AWG class B, C, or K copper wire

10. Control wiring for DMX, station bus, and Emergency input terminations shall land on a removable headers for contractor installation

C. User Interface

1. The user interface shall contain an LCD display with button pad to include 0-9 number entry, up, down back arrow navigation and enter

2. Test shortcut button shall be available for local activation of preset, sequence and set level overrides

3. The user interface shall have a power status LED indicator (Blue), a DMX status LED indicator (Green), a network status LED indicator (Green) and an LED indicator (red) for errors

4. Interface shall allow the backlight to timeout and shall provide user editable options to shut off backlight completely as well as adjust screen contrast

5. Ethernet interface shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible

6. The control interface shall support a USB memory stick interface for uploads of configurations and software updates

7. The user interface shall support power input from an external Uninterruptible Power Supply (UPS) supplying 800W-2400W AC power

D. Functional

1. Panel setup shall be user programmable. The control interface shall provide the following breaker setup features (per circuit):

    a. Type (1 pole, 2 pole, or 3 pole)

    b. Name

    c. Circuit Number

    d. DMX address

    e. sACN address

    f. Space Number

g. Circuit Modes

i. Normal (priority and HTP based activation and dimming)

ii. Latch-lock

iii. Fluorescent

iv. DALI

a. On threshold level

b. Off threshold level

c. Include in UL924 emergency activation

d. Allow Manual

2. Breaker panels shall support discrete addressing of each breaker. Panels that are restricted to use of start address with sequential addressing, and cannot assign each 0-10V output control to any internal circuit shall not be acceptable

3. The panel shall be capable of switching 6 poles on or off at once, or in a user-selectable delay per breaker using a period of 0.1 to 60 seconds, in 0.1 second increments

4. An Ethernet connection shall provide advanced control of relays over streaming ACN (sACN) and transmit status, control override, and measured energy usage per branch circuit via an internal Web UI or central monitoring interface

a. Control electronics shall report the following information per branch circuit.

i. Breaker state (On/Off)

ii. Breaker state (Open/Closed)

iii. Current draw (In Amps)

iv. Voltage

v. Energy usage

b. Panels that do not report this information shall not be acceptable.

5. Built-in Control shall include:

   a. Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events

   b. Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting breaker state on each breaker, or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space

   c. Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet

   d. Indication of an active preset shall be visible on the control panel display

   e. One 16-step sequence per space for power up and power down routines

   f. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting included breakers to “on”, while setting non-emergency breakers “off”. Each breaker can be selected for activation upon contact input

   g. Upon Data loss the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority

   h. Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable

   i. After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets, sequences and zones, or local overrides) is received to make each breaker change state

6. The control of lighting and associated systems via timed and Astronomical clock controls

   a. The breaker panel shall allow the activation of presets, sequence, and zone programming of up to 50 time clock events via a built in real and astronomical time clock

b. System time events shall be programmable via the control panel
   i. Time clock events shall be assigned to system day types. Standard day types include: everyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday
   ii. Time clock events shall be activated based on sunrise, sunset, time of day or periodic event
   iii. System shall automatically compensate for regions using a fully configurable daylight saving time
   iv. Presets shall be assigned to events at the time clock

c. The time clock shall support event override

   i. It shall be possible to override the timed event schedule form the face panel of the time clock

d. The time clock shall support timed event hold
   i. It shall be possible to hold a timed event from the face panel of the processor
   ii. Timed event hold shall meet California Title 24 requirements

7. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad with any circuit patched to any DMX control address

   a. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components

   b. The breakers shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz

   c. Setting changes shall be able to be made across all, some, or just one selected breaker in a single action from the face panel

   d. DMX data loss shall allow for levels/breakers to be held for ever or for a specified time before switching to a lower priority source

      i. Initial Panel setup

1) The breaker panel shall automatically detect the type of breaker or dimmer installed in each location without need for manual configuration of the physical arrangement
2) Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address
3) Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting

E. Electrical

1. Breaker Panels shall be available to support power input from:

   a. 120/208V three phase 4-wire plus ground
   b. 120/240V single phase 3-wire plus ground

2. Conduit Entry

   a. Feeders:
      i. Top or upper 6” of either side
      ii. Bottom or lower 6” of either side
      iii. Feeders shall enter through the top or bottom according to the orientation of the enclosure.
      iv. Feeder entry shall be nearest to the location of the feeder lugs or main breaker.

   b. Load

      i. Load wiring shall enter through the top or bottom of the enclosure through the surface nearest to the breaker sub panel
      ii. Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If class 2 chase is required, a field installable barrier panel shall be provided upon request. The side of the panel where the barrier has been installed shall not permit load wiring

   c. Low voltage

      i. Top or upper 6” of either side
      ii. Bottom or lower 6” of either side
      iii. For low voltage conduit entry at the breaker end of the cabinet, conduits shall be located at the outer 3” of the top/bottom panel

3. Breaker
    a. Bus connection type: Stab on
    b. 1, 2, or three poles
    c. UL489 listed
    d. 15 amp, 20 amp, or 30 amp
    e. 22,000 SCCR; 65,000A series rated with main breaker
    f. High inrush trip curve (matches all Sensor breakers)
    g. Maintains trip curve through entire thermal range
    h. Guaranteed not to trip at full load
    i. Load lugs accept 6-14awg load wiring
    j. Multi-conductor listed output terminal
    k. Integral mechanically held air gap relay
    l. Manual control of relay state using breaker handle w/o power
    m. Integral current sensing
    n. Integral position and trip sensing
    o. Control and status provided by contact pads directly at bottom of the breaker case
    p. No external wires or connections required for control or feedback
    q. The breaker shall be capable of switching up to 30A

4. The breaker panel shall support a maximum feed size: 100 Amps at 12 circuits, 200 Amps at 24 circuits, 400 Amps at 48 circuits
    a. Breaker panels shall support main circuit breaker options:
    b. Main breaker options shall be optional and available for purchase upon request
    c. Main breakers shall be field installable
    d. Main breakers shall be available in up to 100 Amps for 12 circuit panels, up to 200 Amps for 24 circuit panels, and up to 400A for 48 circuit panels at 120V
    e. Series SCCR ratings apply as follows with appropriate main breaker:
        i. 22,000A or 64,000 at 120/208V
    f. Main breakers shall allow the following range of wire sizes:
        i. Up to 300kcmil at 100A and 200A
        ii. Up to 2x250kcmil at 400A
    g. Main Lug input shall support up to 2x250kcmil
    h. Breaker panel shall support a 500kcmil main lug option for 48-circuit panels

5. Breaker remote switching ratings
    a. Mechanical 1,000,000 cycles
    b. 24A Resistive 100,000 cycles
    c. 16A Ballast (HID) 75,000 cycles
    d. 15A Electronic (LED) 100,000 cycles
    e. 15A Tungsten 45,000 cycles
    f. 30FLA; 180 LRA Motor Load 50,000 cycles
    g. Tested duty cycle: 12 operations (6 cycles) per minute
    h. Decreasing duty cycle significantly increases switch life
    i. Isolation: 4000V RMS
    j. Current reporting accuracy: 5%

k. Latching state mechanical relay

6. Breaker Panel Accessories
   a. A low voltage 0-10V dimming option shall provide up to 24 0-10v control outputs that are linked to relay circuits within the panel. Each output shall support up to 400mA of current sink per output
   b. A contact input option shall provide 24 dry contact inputs to be linked for direct or group relay control, to activate a preset, or to activate a sequence. Controller software shall allow for normally open maintained, normally closed maintained, or momentary toggle
   c. A DALI control option shall provide 24 control loops of broadcast DALI control, with each loop controlling up to 64 DALI devices
   d. A RideThru option shall provide short-term power backup of control electronics by automatically engaging when power is lost, and recharging when normal power is present
   e. An Isolated Ground option shall provide each circuit in the panel with a ground terminal that is electrically isolated from the equipment ground
   f. Main Breaker options shall be available as shown in Section E.4

7. Thermal
   a. The panel shall be convection cooled. Panels that require the use of cooling fans shall not be acceptable
   b. The panel shall operate safely in an environment having an ambient temperature between 32ºF (0ºC) and 104ºF (40°C), and humidity between 5-95% (non-condensing)

2.3 LED WASH FIXTURES

A. Colour mixing Light Emitting Diode Wash fixture

B. General

1. The fixture shall be a colour-mixing high-intensity LED illuminator with DMX control of intensity and colour. The fixture shall be a ColorSource PAR as manufactured by Electronic Theatre Controls, Inc. or approved equal.

2. All LED fixtures shall be provided by a single manufacturer to ensure compatibility

3. The fixture shall be CE compliant and UL 1573 listed for stage and studio use

4. The fixture shall comply with the USITT DMX512-A standard

5. The fixture shall be provided with the minimum warranty of 5 years full fixture coverage and 10 years LED array coverage

6. ColorSource PAR

    a. The fixture shall have a LM-84 report with a L70 rating of no less than 55,000 hours

        i. Substitutes must provide evidence of minimum L70 rating of no less than 55,000 hours

            1) If no LM-84 report is available, an acceptable alternate is a LM-80 report on all emitters with a LM-79 report and an in situ temperature measurement test verifying the conditions of the fixture meet the conditions of the LM-80 report.

            2) All tests and reports must be completed by a Nationally Recognized Testing Laboratory.

            3) All tests must be conducted to IES standards

    b. ColorSource PAR Pearl

        i. All LED emitters must have a L70 rating of no less than 60,000 hours

        ii. Substitutes must provide evidence of minimum L70 rating of no less than 60,000 hours via a LM-80 report on all emitters

            1) LM-80 report must be provided with a LM-79 report and an in situ temperature measurement test verifying the conditions of the fixture meet the conditions of the LM-80 report

            2) All tests and reports must be completed by a Nationally Recognized Testing Laboratory

            3) All tests must be conducted to IES standards

C. Physical

1. The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits.

2. The housing shall have a rugged black powder-coat finish

a. White or silver/gray powder-coat finishes shall be available as colour options

b. Other powder-coat colour options shall be available on request

3. Power supply, cooling and electronics shall be integral to each unit.

4. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories

    a. Slots shall be equipped with locking retaining clip

5. The unit shall ship with:

    a. Theatrical-style hanging yoke as standard
    b. 1.8m PowerCON to flying leads power cable
    c. Available options shall include but not be limited to:
    d. Floor stand conversion Kit
    e. PowerCON to PowerCON cables for fixture power linking
    f. Multiple secondary lens options to include multiple angles in the following patterns:
        i. Linear
        ii. Round
        iii. Oblong

6. Light output shall be via a round aperture

    a. Aperture and accessory slots shall accommodate standard 190mmx190mm accessories such as used in other similar-sized fixtures

    b. Accessories available as options shall include but not be limited to:

        i. Gel/diffusion frames
        ii. Top hats
        iii. Barn doors
        iv. Egg crate louvres
        v. Concentric ring louvres
        vi. Multiple secondary lensing options

7. Environmental and Agency Compliance

    a. The fixture shall be CE compliant, and shall be so labelled when delivered to the job site.

b. The fixture shall be UL LISTED to the UL1573 standard for stage and studio use

c. The fixture shall be rated for IP-20 dry location use.

8. Thermal

a. The fixture shall be cooled with a variable speed fan.

b. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use for colour mixing versions and 36,000 hours of use for Pearl variety

i. Thermal management shall include multiple temperature sensors within the housing to include:

1) The LED array
2) The control board

c. The fixture shall operate in an ambient temperature range of 0°C minimum to 40° C maximum ambient temperature

9. Electrical

a. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply

b. The fixture shall support power in and thru operation

i. Power in shall be via Neutrik® PowerCON input connector
ii. Power thru shall be via Neutrik ® PowerCON output connector
iii. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker

c. The fixture requires power from non-dim source

d. Power supply outputs shall have self-resetting current limiting protection

e. Power supply shall have power factor correction

10. LED Emitters

a. The fixture shall contain 4 different LED colours to provide colour characteristics or two colour temperature white LEDs for the Pearl products, as described in Section H below.

b. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.

   i. Fixture shall utilise Luxeon® Z™ LED emitters

c. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain colour consistency.

d. LED emitters should be rated for nominal 20,000-hour L70 rating for colour mixing versions and 36,000-hour L70 rating for Pearl variant

e. LED system shall comply with all relevant patents

11. Calibration

    a. Fixture shall be calibrated at factory for achieve consistent colour between fixtures built at different times and/or from different LED lots or bins

       i. Calibration data shall be stored in the fixture as a permanent part of on-board operating system
       ii. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency
       iii. Fixtures not offering LED calibration shall not be acceptable

12. Colour

    a. The fixture shall utilise an minimum of 40 LED emitters

       i. These emitters shall be made up of Red, Green, Blue and Lime for ColorSource
       ii. These emitters shall be made up of Red, Green, Indigo and Lime for ColorSource Deep Blue
       iii. These emitters shall be made up of 2700 K and 6500 K for ColorSource Pearl

13. Dimming

    a. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming.

b. The dimming curve shall be optimised for smooth dimming over longer timed fades.
c. The LED system shall be digitally driven using high-speed pulse width modulation (PWM)
d. LED control shall be compatible with broadcast equipment in the following ways:
    i. PWM control of LED levels shall be imperceptible to video cameras and related equipment
    ii. PWM rates shall be adjustable by the user via RDM to avoid any visible interference to video cameras and related equipment

14. Control and User Interface

a. The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors

b. The fixture shall be compatible with the ANSI RDM E1.20 standard

    i. All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
    ii. Temperature sensors within the luminaire shall be viewable in real time via RDM
    iii. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible

a. The fixture shall be equipped with a 7-segment display for easy-to-read status and control

b. The fixture shall be equipped with a three-button user-interface

c. The fixture shall offer RGB control

d. The fixture shall operate in Regulated mode for droop compensation

e. The fixture shall offer stand-alone functionality eliminating the need for a console

f. Fixture shall ship with 12 pre-set colours accessible as a stand-alone feature

g. Fixture shall ship with 5 Sequences accessible as a stand-alone feature

h. Each colour and sequence can be modified by the end user

i. Fixtures can be linked together with standard DMX cables and controlled from designated master fixture

j. Up to 32 fixtures may be linked

k. Fixtures in a stand-alone state shall restore to the settings present prior to power cycling, eliminating the need for reprogramming

l. Fixtures without stand-alone operation features described in a, b, c, d, and e, shall not be acceptable.

2.4 LED SPOT FIXTURES

A. Colorsource LED fixture - General

1. ColorSource Spot, four-color light engine with red, green, blue, and lime LED emitters as manufactured by Electronic Theatre Controls, Inc. or approved equal.

a. Standards Compliance:
i. Listed: cETLus, UL 1598, UL 924, CSA C22.2 No. 250.0.
ii. Compliance: CE.

B. Light Source

1. LED Details: 60 Lumileds LUXEON Rebel and LUXEON C LEDs.

2. Max Lumens: 9300

3. Lumens per Watt: 47.2.

4. L70 Rating: Greater than 54000 hours.

C. Colors:

1. Colors Used Spot: Red, green, blue, lime.

2. Color temperature Range: Color mixing.

3. Calibrated Array: Yes.

4. Red Shift: No.

D. Optical

1. Beam Angle Range: 5 to 90 degrees. Swappable lens tubes.
2. Gate Size: 80 mm.
3. Aperture Size: 6.25 to 14 inches depending on lend tube.
4. Pattern Projection: Yes.
5. Pattern Size: A or B.
6. Camera Flicker Control/Hz Range: 5 kHz and 25 kHz.

E. Control

1. Input Method:
    i. DMX-512 via 5-pin XLR connector. Protocols: DMX512, RDM.
    ii. City Theatrical Multiverse. Protocols: DMX512, RDM
2. NFC Configuration: Yes, via Set Light app.
3. RDM Configuration: Yes.
4. User Interface Type:
    i. ColorSource Spot V: 7-segment 3 button interface.
5. Local Control: Yes. (ColorSource Spot V only)
6. Onboard Presets: Yes, 12. Onboard Sequences: Yes, 5. Onboard Effects: No.
7. Fixture-to-Fixture Control: Yes.
8. 15-bit virtual dimming engine.

F. Electrical

1. Voltage: 100 to 240 VAC, 50 to 60 Hz.

2. Input Method: power-CON True 1 TOP in and thru.

3. Inrush First Half Cycle: 55 A at 120 V. 59 A at 240 V.

4. Fixtures per Circuit:

    i. Eight. (R20 module or similar).

5. Thermal: Operating Temperature: 32 to 104 degrees F

    i. Fan: Yes. Controllable.
    ii. Droop Compensation: Yes.
    iii. BTUs/hour: 671.77

6. Physical: IP Rating: ColorSource Spot: IP-20.

    i. C Materials: Die-cast aluminum. Colors: Black, white, silver, or custom.
    ii. Mounting Options: Yoke.
    iii. Included Accessories: Hanging yoke, 39-inch power cable, soft-focus diffuser in an A-size gobo holder.

7. Provide compatible lens as indicated on the bid documents. Lens shall include:

    i. 15-30 deg zoom lens
    ii. 19 deg lens
    iii. 26 deg lens
    iv. 36 deg lens

2.6 LIGHTING CONTROL – BUTTON AND FADER STATIONS

Button Stations

1. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
2. Mechanical
    a. Unison Heritage Button stations shall operate using up to ten programmable buttons.
    b. All button stations shall be available with white, cream, ivory, grey or black faceplates, and buttons.
        i. Manufacturer's standard colours shall conform to the RAL CLASSIC Standard.
    c. Stations shall have indicator lights at each button or fader.
        i. Indicators shall be comprised of red, green and blue LED's
        ii. Indicator colour and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
    d. All faceplates shall be designed for flush or surface mounting.
    e. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
    f. Station faceplates shall be indelibly marked for each button or fader function.
    g. The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
    h. All Button stations shall be shall be designed to accept the infrared signal from a remote hand held IR transmitter.
        i. The stations shall have a 60° reception angle and shall operate reliably within a 14m distance.
    i. IR Transmitters shall be available in five or ten button configurations.
        i. IR transmitters shall be mounted in a hand-held black plastic controller.
        ii. Transmitter dimensions shall be 47.6mm wide, 168.3mm long and 15mm deep.
3. Electrical
    a. Unison control station wiring shall be an Echelon® Link power network.
        i. Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one 2.5mm^2 ESD drain wire (when not installed in grounded metal conduit).
        ii. Network wiring may be bus, loop, home run, star or any combination of these.

iii. Wiring termination connectors shall be provided with all stations.

b. Button Stations shall offer the following Regular markings

i. UL and cUL LISTED

ii. CE compliant

iii. RoHS and WEE Compliant

4. Functional

a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.

i. System presets shall be programmable via Button stations, Touchscreen stations, and Unison Paradigm LightDesigner software.

a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.

b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.

ii. System macros and sequences shall be programmable via LightDesigner system software.

a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.

b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.

iii. System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.

a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.

b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.

i. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.

ii. Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

c. Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.

Fader Stations

5. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.
6. Mechanical
   a. Unison Heritage Fader Stations shall operate using up to sixteen programmable faders and twelve programmable buttons.
   b. All fader stations shall be available with white, cream, ivory, grey or black faceplates, fader knobs, and buttons.
      i. Manufacturer's standard colours shall conform to the RAL CLASSIC Standard.
   c. Fader stations shall utilise standard 45mm slide potentiometers.
   d. Stations shall have indicators lights at each button or fader.
      i. Indicators shall be comprised of red, green and blue LED's
      ii. Indicator colour and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
   e. All faceplates shall be designed for flush or surface mounting.
   f. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
   g. Station faceplates shall be indelibly marked for each button or fader function.
   h. The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
   i. Fader stations shall be shall be designed to accept the infrared signal from a remote hand held IR transmitter.
      i. The stations shall have a 60° reception angle and shall operate reliably within a 14m distance.
   j. IR Transmitters shall be available in five or ten button configurations.
      i. IR transmitters shall be mounted in a hand-held black plastic controller.
      ii. Transmitter dimensions shall be 47.6mm wide, 168.3mm long and 15mm deep.
7. Electrical
   a. Unison control station wiring shall be an Echelon® Link power network.

i. Link power shall utilise low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one 2.5mm^2 ESD drain wire (when not installed in grounded metal conduit).

ii. Touchscreen and Interface stations shall also require (2) 1.5mm^2 stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.

iii. Network wiring may be bus, loop, home run, star or any combination of these.

iv. Wiring termination connectors shall be provided with all stations.

b. Fader Stations shall offer the following Regular markings

i. UL and cUL LISTED

ii. CE compliant

iii. RoHS and WEE Compliant

8. Functional

a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface, or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.

i. System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.

a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.

b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.

ii. System macros and sequences shall be programmable via LightDesigner system software.

a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.

b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.

iii. System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.

a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.

b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.

i. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.

ii. Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

c. Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.

Portable Plug-in Stations

9. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.

10. Mechanical

a. Unison connector stations shall provide an interface to portable Unison stations.

b. All connector stations shall be available with white, cream, ivory, grey or black faceplates.

i. Manufacturer's standard colours shall conform to the RAL CLASSIC Standard.

c. All faceplates shall be designed for flush or surface mounting.

d. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.

e. Station faceplates shall be indelibly marked with station function.

f. The manufacturer shall supply back boxes for all surface mounted stations.

11. Electrical

a. Unison control station wiring shall be an Echelon® Link power network.

i. Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one 2.5mm^2 ESD drain wire (when not installed in grounded metal conduit).

ii. Portable plug-in stations shall also require (2) 1.5mm^2 stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.

iii. Network wiring may be bus, loop, home run, star or any combination of these.

iv. Wiring termination connectors shall be provided with all stations.

b. Portable Plug-in Stations shall offer the following Regular markings
   i. UL and cUL LISTED
   ii. CE compliant
   iii. RHoS and WEE Compliant

12. Functional
   a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.
      i. System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.
         a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.
         b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.
      ii. System macros and sequences shall be programmable via LightDesigner system software.
         a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
         b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.
      iii. System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.
         a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
         b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
   b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.
      i. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.
      ii. Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

Locking Covers

13. The Lighting Control Station Locking Covers shall be the Unison Heritage UH Series as manufactured by Electronic Theatre Controls, Inc., or equal.
14. Mechanical
    a. Locking covers shall be available in Sliding Locking for flush mount applications and Hinged Locking for flush and surface mount applications
    b. Sliding Locking Covers shall:
        i. Be available with white, cream, ivory, grey or black faceplates.
        ii. Be constructed of Extruded Aluminium with ABS plastic end caps
        iii. Provide a smoked Plexiglas window to allow for viewing control status and use of IR remote without opening cover
    c. Hinged locking covers shall:
        i. Be available in standard black powder coat finish
        ii. Be constructed of 18 gauge steel and finished in standard black powder coat paint, or custom colour as specified.
        iii. Provide a clear Plexiglas window to allow for viewing control status and use of IR remote without opening cover
        iv. Use internal Hinge that is not accessible when the cover is closed
    d. Standard colours shall conform to the RAL CLASSIC Standard.
    e. Locking covers of the same type shall be keyed alike
    f. The manufacturer shall supply back boxes for all hinged locking covers.
15. Functional
    a. All locking covers shall utilize 90-degree locking mechanisms
        i. Keys shall be held captive in locks when covers are unlocked.
    b. Locking covers shall allow for easy viewing of system status without opening the cover
    c. Locking covers shall support IR remote activation of configured system functions without opening door

2.7 POWER DISTRIBUTION – CONNECTOR STRIPS

A. The connector strips shall be the ColorSource Raceway by ETC, Inc., or approved equal

B. General

a. Connector strips shall provide distributed power form incoming circuits to plugs along a raceway
b. Internal wiring shall be sized to circuit ampacity and shall be rated at 125°C
c. Connector strips shall support a combination of line voltage power and low voltage data distribution within a single raceway.

d. Connector strips shall be listed by a nationally recognized test lab (NRTL). Connector strips that are not listed shall not be acceptable

C. Physical

a. Connector strips shall be 127mm H x 45mm D and fabricated from 1.6mm aluminum finished in black, white, or silver fine-texture powder coat paint
b. Connector strips shall be available in any length up to 72ft / 2195cm in specified increments of 1ft / 30.5cm and shipped fully wired with all splicing hardware
c. Connector strips shall weigh no more than 2.5lbs/ft. Connector Strips that weigh more than 2.5lbs/ft shall not be acceptable
d. Two connector panels supporting power and data outlets shall be supported for each 1ft / 30.5cm section of strip and shall be mounted on individual 125mm panels
e. Frames and connector panels shall be fabricated from 3mm die cast aluminum finished in black, white, or silver fine-textured powder coat paint
f. Circuits shall be labeled above each connector on the front of the strip using 15mm reverse silk screened lexan labels. All labels match connector strip finish with contrasting color circuit designations. Optional write-on labels shall be available upon request, connector strips that do not support write-on labels shall not be acceptable
g. Connector strips shall support the use of QR code labels which allow users to access limited circuit configuration controls via Wi-Fi connection from a mobile device application. The mobile application shall be the ThruPower System Reporter (TPSR) app by ETC.
    i. Mobile application shall select the circuit to configure either by scanning the QR code label applied to circuit distribution or by manual entry of circuit information
    ii. Mobile application shall allow users to set the Control Mode of the selected circuit in order to shift a ThruPower module between Dimmable and Switched mode according to the requirement of a connected load
    iii. Mobile application shall allow users to activate the circuit test function for the selected module
    iv. Circuit distribution systems which do not support mobile circuit configuration from the plugin location of a supported load shall not be acceptable
h. Connector strips shall be supplied with appropriate brackets and hardware for mounting.
i. Connector strips shall utilize junction brackets on 6ft / 152cm centers and support spans up to 12ft / 305cm between hanger brackets
j. Mounting brackets shall be 45mm x 3mm and 45mm x 1.9mm ASTM A5008 steel. All mounting hardware shall conform to ISO 898-1 class 8.8

D. Electrical

a. Connector strip shall support 120V/60Hz power input per branch circuit with support for multiple outlets wired to each circuit
b. The connector strip wiring terminal box shall support a maximum of eight 20A inputs utilized for:
    i. Up to six circuits for power distribution along the length of the connector strip
    ii. One circuit dedicated for work lights.
    iii. One circuit for DMX Active Pass-thru connectors when required
c. The connector strip terminal box shall support hardwired or pluggable connector power and data input
d. Pluggable power and data inputs shall be fed by a single multi-conductor cable and a single DMX or Ethernet cable. The LKS data connector by Link S.r.l. or Link USA, Inc shall be supported, connector strips that do not support the LKS data connector shall not be accepted
e. Power output connectors shall be available as 20A grounded stage pin, 20A Twist-Lock, 20A "U" ground (dual rated "T-slot"), and 20A Neutrik powerCON TRUE1. Connector strips that utilize connectors that are not rated for plugging hot loads shall not be accepted.
f. Terminations shall be consolidated at one end and utilize feed-through terminals individually labeled with corresponding circuit numbers
    i. Performance lighting circuits shall utilize tension clamp terminals listed for AWG 20 – 8 / 0.5mm2 – 6mm2 gauge wire
    ii. Work light and DMX Active Pass-thru circuits shall use tension clamp terminals listed for AWG 20 – 12 / 0.5mm2 – 4mm2 gauge wire
    iii. Terminals that place a screw directly on the wire are not acceptable
g. A low voltage data distribution system shall be supported to incorporate DMX/ RDM (ANSI E1.11-2008 USITT DMX512-A and ANSI E1.20 Remote Device Management) or Ethernet (IEEE 802.3).
    i. Ethernet connections shall utilize standard RJ-45 connection
    ii. DMX output ports shall utilize 5-pin XLR style connectors
    iii. Connector strips shall utilize a voltage barrier to accommodate class 2 wiring in the same strip as class one circuits.
    iv. Low voltage signals shall enter the connector strip via a strain relief or connector mounted at the specified end of the connector strip. One low voltage cable shall be supported for each connector strip
    v. Connector strips with multiple DMX outputs shall use active DMX/RDM pass through assemblies. Each strip shall support up to 24 active DMX/RDM pass through assemblies
    vi. DMX outputs without active splitting of the DMX/ RDM signal or that do not support RDM shall not be acceptable

E. Pipe Batten

a. A pipe batten with a 48.3mm outside diameter constructed of 3.8mm extruded aluminum with a 3.8mm vertical web shall be available for use with the connector strip
b. The pipe batten shall be extruded with a witness line to indicate the position of the web
c. The pipe batten shall support a maximum distributed load of 150lb / 68kg over a 10ft / 305cm span
d. The pipe batten shall support a maximum point load of 65lb / 29kg over a 10ft / 305cm span
e. The pipe batten shall weigh no more than 1.5lbs/ft, battens that weighs more than 1.5lbs/ft shall not be acceptable
f. The pipe batten shall be designed to a 10:1 safety factor
g. The pipe batten shall be finished with black or clear hardcoat anodization

F. Work Lights

a. Connector strips shall support optional integrated LED work lights
b. The work lights shall mount to the bottom of the supplied hanger bracket
c. A connector plate shall be available to install a power supply for the work light
d. The work light shall be a 25W 3000K CCT LED array at 90 CRI
e. The work light shall produce 1600 lumens
f. The work light shall have a 60° beam angle
g. Connector strips that do not support integrated LED work lights shall not be acceptable

G. Junction Boxes

a. Gridiron junction boxes shall be available to accommodate “S” type cable wiring into connector strips mounted to non-fixed locations
b. Junction boxes shall accommodate hardwired or pluggable cables including LKS data connector by Linek S.r.l. or Link USA, Inc. Junction boxes that do not support the LKS data connector shall not be acceptable
c. Junction boxes shall be fabricated from 16-gauge cold rolled steel with 14-gauge end panels
d. Cover(s) shall be 16-gauge cold rolled steel and hinged to allow mounting in any direction
e. Junction Boxes shall be finished with fine-textured, scratch-resistant, powder coat paint

PART 3 EXECUTION

3.1 CONTRACTORS DOCUMENTATION

A. As-Built Drawings. Provide three (3) sets. The Contractor shall provide complete point to point wiring schematics of all system components of the theatrical lighting system and control.

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 CD Rom or Thumb Drive.

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 and provided with the as-builts.

E. Manufacturer Documents - Provide three (3) sets. All equipment item manufacturer manuals shall be provided as a part of the Contractors documentation package. All manuals are to be inserted into 3 ring binders. Also included in these binders are to be a complete equipment list of the serial numbers and manufacturer warranty information

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 control cabling will be installed within the NEC installation parameters for application and routing

H. Cabling:

a. All cabling will be installed in a neat and orderly fashion

b. Cabling will be secured and strain-relieved at all appropriate locations

c. All cable connections to equipment will have maximum accessibility and cable labels will be visible.

d. Any piece of equipment will be removable without cutting wire ties or cable harnesses

e. Service loops will be provided where necessary.

f. All cables run through plenum environments will be Teflon-jacketed in accordance with local fire codes.

g. Cables will not be gouged, bent, or otherwise damaged during installation or termination. Cables will not rest against any sharp metal edges. Grommets, plastic collars, or rubberized tape will be used where appropriate

h. Cables and bundles will be dressed to look neat, orderly, and with the idea that a technician, who may be unfamiliar with the system, can find his or her way around the system with the aid of the documentation

3.4 MANUFACTURER'S SERVICES

A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the owner that the system is available for formal checkout.

B. Notification shall be provided in writing, two weeks prior to the time factory-trained personnel are needed on the job site if applicable.

C. The contractor shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.

D. Upon completion of the formal check-out, the contractor shall demonstrate operation and maintenance of the system to the owner's representatives. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system. The first training session shall be a minimum of four hours. Training shall consist of detailed operating functions, and hands on system and overall explanations of each systems capabilities and functionality. A user's manual shall be used as a guide for training. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of two hours.

3.5 OWNER TRAINING

A. Training shall be provided to the owner for all installed systems. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system.

a. Each training session shall be a minimum of two hours.

b. Training shall consist of detailed operating functions and overall explanations of each systems capabilities and functionality.

c. A user's manual shall be used as a guide for training.

d. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of one hour

e. Contractor shall be present for the first event during operation.

f. All training sessions shall be video-taped. The tape shall be turned over to the Owner for future reference

3.5 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

C. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.

D. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.

END OF SECTION 26 6000

SECTION 27 1000 – CAFETERIA & GYM 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 of greater system performance and function. No substitute equipment shall be purchased or installed without approval by the Engineer.

E. Final approval of the substituted equipment shall be given after the system has been installed. Failure to meet the specification, as determined by the Engineer, shall result in the removal of the substituted equipment and the installation of the specified equipment without any additional cost to the owner.

F. When a piece of specified equipment has been discontinued by the manufacturer or is unavailable due to lack of inventory, the contractor may substitute the manufacturers recommended replacement without notice to the Engineer. If a piece of equipment is not replaced by a newer model with the same or better features and a different manufacturer can supply a piece of equipment that meets or exceeds the original equipment, the contractor shall notify the Engineer and submit the equipment cut sheets for approval.

1.5 EXCEPTIONS

A. Any and all exceptions to these specifications and related drawings must be made with the submission of the bid. In the absence of exceptions, the specifications and related drawings shall be binding in letter and intent on the successful bidder. It will also be understood that the bidder has examined the design and specifications in detail, and is prepared to take full responsibility for the performance of the complete installation as designed and specified.

1.6 SUB-CONTRACT INFORMATION

A. Any and all sub-contractors that a bidder plans to utilize for this project are to be listed with the references and qualifications in the bid submission. The successful bidder shall supervise all sub-contract work. Any and all sub-contract work is the complete and sole responsibility of the contractor.

1.7 SPECIFICATION INFORMATION REQUESTS AND QUESTIONS

A. Any requests for clarification shall be submitted to Mr. DJ Seibert of Snyder Hoffman Associates, 1005 West Lehigh Street, Bethlehem, PA, 18018, 610-694-8020, dseibert@snyderhoffman.com. All requests are to be made in writing and submitted no later than ten days prior to bid submission.

1.8 CERTIFICATIONS AND REPRESENTATIONS

A. Quality of materials: All equipment items and installation materials will be new. No previously owned, demonstrated or otherwise used items will be provided. Note that prior to equipment installation and on-site integration, all equipment items shall be performance tested and quality checked to insure full functionality of each equipment item.

B. Tax Statement Certification: The contractor certifies that all local, state, and federal taxes are separately listed in any price quotations.

1.9 QUALITY ASSURANCE

A. All equipment and materials provided for this contract are to be new and shall meet or exceed the latest published specification of the manufacturer for that item.

B. All equipment shall be UL listed or equivalent.

1.10 NOT IN CONTRACT

A. Some equipment related to the audio system will be provided under the Electrical Contract. Unless otherwise indicated in these specifications or related drawings, these will include the following:

1. All electrical breaker / load panels.

PART 2 PRODUCTS

2.1 EQUIPMENT DESCRIPTION

A. System Electronics:

1. The Cafeteria & Gymnasium shall be provided with a complete locally controllable audio system. All equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electronically whether or not those specifications are delineated herein. The manufacturer's latest published specifications shall be considered as part of this text. Quantities shown on the contract drawings.

2. Digital Multiprocessor: Provide (2) Ashly ne24.24M or equal. The digital signal processor base unit shall consist of four inputs and four outputs and shall use modular expansion cards to provide up to twenty-four channels of input / output audio matrixing and processing. Each expansion card shall have an individual DSP processor allowing for expansion of the base

unit's total inputs or outputs four channels at a time. Expansion cards shall be factory installed or easily installed in the field without the need to reprogram. The processor shall use fixed path architecture to reduce set-up time. The processor control and programming shall be accomplished using a PC platform through a standard Ethernet connection.

An RS-232 jack shall be provided for control and monitoring by a third-party controller. Multi-level security and no front panel controls shall insure tamper-resistant operation. Input channel processing blocks shall include a Mic/Line Preamp with 48V Phantom Power, Gain, Pink Noise Generator, Delay, fifteen EQ Filters, Gate, Autoleveler and Ducker. Output channel processing blocks shall include a Cross-Point Mixer, HPF/LPF, Delay, fifteen EQ Filters, Gain, and Limiter.

The cross point mixer shall allow any input to be routed to any output at any level and mute any input at any output without affecting the true input configuration. Rear panel Euroblock connectors shall include eight preset recall contact closures plus eight remote potentiometer level controls.

The DSP processor shall mount in a standard 19" rack using 2 spaces (3.5" high).

3. POWER AMPLIFIERS: Provide (2) Ashly CA-1.04 Class D power amplifier or equal. The amplifier shall be a 4-channel configuration of Class D design housed in a 2RU metal chassis with a metal front, including handles on either side. The front panel shall be equipped with input levels knobs and LED indicators for Temp, Current, Input signal (-45dB) and Clip/Mute (one for each channel). There shall also be general LED indicators for Protect Mode and Disable (indicates front panel lock). There shall be a front panel Power button that can switch between Power On and Standby Modes with an LED backlight to indicate status (Solid-ON, Blinking-Standby). The front panel shall be perforated on either side to allow proper air intake for cooling and dual variable-speed fans shall be mounted behind the vent.

   The amplifier's rear panel shall be equipped with 3.5mm removeable Balanced Euroblock connectors for each input as well as an XLR/1/4" combo jack. There shall also be a removeable 3-pole 3.5mm Euroblock connector for DC level control per channel. There is also a standby port for remote control of standby functions. A push-buttom switch selects Normal or Bridging operation for each channel pair. A set of DIP switches per channel allow a selectable 80Hz HPF and clip limiter to be switched on or off and for selecting amp gain of 26dB, 32dB, 38dB or 1.4V per channel. There shall also be DIP switches for front panel lockout and standby port polarity (NO/NC). The speaker outputs shall be a 4-pole 7.62mm removeable Euroblock for each channel pair. The two positive poles are set to deliver bridged power when required. There shall be a locking IEC power connection and the unit shall be supplied with the region-appropriate power cable.

   The amplifier shall be capable of driving up to 1,000W @ 2/4 Ohms or 70V per channel and 500W @ 8 Ohms per channel. The amplifier can also deliver 2,000W at 8 Ohms or 100V when in Bridge Mode. The amplifier shall have a universal power supply capable of operating from 100-240VAC, 50/60Hz and will have a current consumption @ 1/8 rated output of 6A. The amplifier housing shall measure 19" x 3.5" x 14.84" with a net weight of 21lbs.

4. Media Player with Bluetooth Receiver and AM/FM Tuner: Provide (2) Denon Pro DN-300Z or equal. The media player shall feature:
    1. Super-fast loading, slot-in CD mechanism
    2. Supports removable USB thumb and HDDs, SD/SDHC cards
    3. Wireless audio playback from devices via Bluetooth
    4. Plays CD, MP3, WAV, and AAC files
    5. 3.5mm Aux-in for audio playback of other devices
    6. AM/FM Tuner w/ dedicated audio out for multi-room use
    7. Unbalanced combi audio output
    8. 10-key direct track access
    9. Random, Repeat One, Repeat All, and continuous play modes
    10. Folder only and All play modes
    11. IR controllable with included, compact remote
    12. 1RU chassis with removable rack ears
    13. Detachable IEC-weighted AC inlet
    14. 100-220v switching power supply

    Number of channels: 2 (stereo), 1 (mono), Audio frequency characteristics: 10Hz – 20kHz (+ 1.0 dB), S/N ratio: More than 95 dB (A-Weighted), Total harmonic distortion: Less than 0.01%, Dynamic range: More than 85 dB, Channel separation: More than 80 dB.

    Bluetooth: Version 3.0, Output class: Class 2, Support Codec: SBC, MP3, AAC, aptX, Support Profile: A2DP, AVDTP 1.0, AVCTP 1.3, AVRCP 1.0, SSP.

    Tuner Section: FM AM, Receiving range; North and South America: FM- 87.50 MHz–107.90, AM- 520 kHz – 1710 kHz, Sensitivity: 30 dBµV / m 60 dBµV / 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 kΩ/kohms, Output level: 2 Vrms / at 10 kΩ/kohms load.

    Input Section: AUX-in: Type: TRS terminal (Ø 3.5), Input impedance: Over 10kΩ/kohms, Maximum input level: 1 Vrms, Maximum output level: 3 Vrms

5. Microphones and cables: The following microphones, cables, and stands shall be provided for various assembly purposes:
    a. Wireless Microphones: Provide (6) Shure SLXD124/85/ diversity receiver with one handheld microphone transmitter and wireless lavalier transmitter. See locations on the plans.
    b. Provide (8) Shure SM58-CN cardioid, dynamic microphones.
    c. Provide (4) Shure SM57 Dynamic instrument microphones.
    d. (12) XLR male to XLR female shielded microphone cables, (25) feet in length.
    e. (12) 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.

6. LOUDSPEAKERS

Soundtube HP890I or equal (See plans for locations and quantities):
The loudspeaker shall consist of a 203 mm (8.0 in.) low-frequency transducer and a 36 mm (1.42 in.) high-frequency compression driver (1.0 inch exit) with a BroadBeam HP® waveguide and a crossover network installed in the ported enclosure. The low-frequency voice coil diameter shall be 34 mm (1.34 in.).

Performance specifications of a typical production unit shall be as follows: Useable frequency response shall extend from 65 Hz – 22 kHz (-10 dB). Measured sensitivity (2.83-volt input, 1 meter) shall be at least 94.0 dB. The speaker shall have a nominal impedance of 8 ohms. The speaker shall be available for 25-, 70.7- and 100-volt modes and shall include a five-position tap switch with a transformer bypass position. The frequency-dividing network shall have a crossover frequency of 2.5 kHz with slopes of 12 dB per octave (2nd order) for the low- and high-pass filters. Rated power capacity shall be at least 125 watts continuous (RMS) and conform to EIA-426-B testing. Maximum continuous output at 1 meter shall be 115.0 dB.

The low-frequency transducer shall have a treated fiber cone with cloth surround. The high-frequency transducer shall be a compression driver with a 1-inch exit.

Installation for the speaker shall be by galvanized steel cable affixed to the speaker chassis via an integrated snap hook. For safety redundancy, a secondary steel cable shall be included. The external wiring input connector shall be a four-pin, 5.08 mm Euroblock for 8 ohm or distributed systems and shall accept from 10 – 22-gauge wire. The system shall be for indoor and outdoor applications and have a weather-resistant boot covering all wire connectors.

The enclosure shall be constructed of injection-molded, glass- reinforced ABS. The grille shall be constructed of powder-coated steel for lasting performance in the elements. Overall cabinet dimensions shall be no more than 437.6 mm (17.23 in.) in height by 376.4 mm (14.82 in.) in diameter and weigh no more than 12.2 kg (26.8 lbs.). The unit shall include hanging hardware, Euroblock connector and weather-resistant terminal boot.

Soundtube HP1290I or equal (See plans for locations and quantities):
The loudspeaker shall consist of one 305 mm (12.0 in.) low-frequency transducer and one 35 mm (1.375 in.) high-frequency transducer with a frequency-dividing network installed in a ported enclosure. The low-frequency voice coil diameter shall be 50 mm (2.0 in.).

Performance specifications of a typical production unit shall be as follows: Useable frequency range shall extend from 59 Hz - 22 kHz, -10 dB. The loudspeaker shall be available with selectable 25/70.7/100-volt tap switch with transformer bypass position. The frequency-dividing network shall have a crossover frequency of 2.2 kHz. Rated power

capacity of the components and network shall be at least 150 watts continuous (RMS) and conform to EIA-426-B testing. Maximum continuous output at 1 meter shall be at least 118 dB.

The low-frequency transducer shall have treated fiber cone material with a treated cloth surround. The high-frequency transducer shall be constructed of Mylar material. Installation for the speaker shall be by galzanized steel cable affixed to the speaker chasis via an integrated snap hook. For safety redundancy, a secondary steel cable shall be included. The external wiring input connector shall be a four-pin, 5.08 mm Euroblock for 8 ohm or distributed systems and shall accept 10-22-guage wire. The unit shall be for indoor and outdoor applications and have a weather-resistant boot covering all wire connections. The system shall ship complete with hanging hardware including hanging and safety cables, Euroblock connector and terminal weather boot. The speaker has an optional surface mount bracket (AC-RS-SM1290)

The ported enclosure shall be constructed from injection-molded, glass-reinforced ABS with a total volume of 2 cubic feet. The grille shall be constructed of powder-coated steel and affix to the speaker via friction fit with two blind-mounted, radial screws.

The unit is factory preset to the 150-watt setting in the 70.7-volt operating mode, with a tap switch located on the front baffle of the speaker, accessible by a removable grille plug. Signal input shall be by four-pin Euroblock connector, which accepts up to 10-gauge wire.

7. Assistive Listening System. The system shall be Williams Sound PPA T45 or equal. Provide (5) bodypacks and (5) Headphones. 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 µS 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, ± 3 dB and the signal-to-noise ratio shall be 65 dB at 10 µV. The receiver shall have a sensitivity of 2µV 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.

8. Rack Enclosures:
    a. 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 including space for rack venting. 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

    b. Provide all necessary mounting hardware for equipment and wiring.

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. Provide stainless steel microphone / line input plates for connection of microphones and line level equipment. Quantity, location, and type of plates are listed on the drawings. The microphone / line input plates shall be terminated and properly marked to the audio rack. All plates shall be engraved as described on the drawings. Silk screen identification will not be accepted. Face plate color shall be stainless steel with black engraved letters.

11. 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, 8x2 4k/60 scaling presentation matrix switcher:
- Frame rate - 24, 25, 30, 50, 60, 120, 144, or 240 fps
- Chroma sampling - 4:4:4 and 4:2:2; 4:2:0 (at input only)
- Color bit depth - 8 or 10 bits per color
- Signal - DVI 1.0, HDMI 1.4 and 2.0, DisplayPort 1.2, HDCP 1.4 and 2.3
- Max. video data rate – HDMI: 18 Gbps (6 Gbps per color), Display port: 21.6 Gbps (5.4 Gbps per lane)

b. Extron Sharelink Pro 500, wired and wireless presentation gateway.
c. Extron DTP T UWP 4K 232 D, Input DTP transmitter
d. Extron DTP HDMI 4K 230 Rx, DTP HDMI receiver
e. Extron DTP HDMI 4K 330 TX, DTP HDMI, Long distance DTP HDMI transmitter.
f. Extron XTP PI 100, Power injector
g. Extron IPCP Pro 250, IP Link Pro control processor
h. Extron TLP Pro 1025M, 10” wall mounted touch panel
i. 10 Port PoE++ AV switch.

12. Provide Sony Blu-Ray BDP-S3700 or equal. Playback Capability: Play/Stop/Pause, PREV/NEXT, REV/FWD, Shuffle, Slow Playback (FWD/REV), step Playback (FWD/REV), Interface: HDMI Output 1 (Rear), Coaxial Digital Audio Output 1 (Rear), USB Input 1 (Front), Ethernet Connection 1 (Rear), Picture and Audio Features: 2D→3D conversion, super scaler (precision cinemahd upscale), deep color (16 bit), 24P true cinema, ntsc/pal, dvd 24p output, HDMI® (480i/ 480p/720p/1080i/1080p (60 Hz), coaxial, optical, Network: WI-FI® built in (2.4 GHz/MIMO)

Child lock, parental control, usb keyboard (101 only) / auto standby, photo slide show with music, live streaming / subtitle / recommendation, bravia sync, firmware update (Network, USB), Power consumption 9.2 W, Eco and energy saving, power consumption (standby mode) 0.25 W, dimensions (W X H X D), 230 x 39 x 194 mm, weight 1lb 13 oz.

2.2 CONTRACTOR'S DOCUMENTATION:

A. As-Built Drawings. Provide three (3) sets. The Contractor shall provide complete point to point wiring schematics of all system components including audio, video and control. Drawings shall include cable numbering, equipment locations, jacks, input /output plates etc.

B. A final set of as-built drawings shall be provided within 10 working days of acceptance by the Owner. Two copies of this as-built information shall be provided one to the Owner and one to the Engineer. As-builts shall be provided on reproducible media, and one CD Rom.

C. The Contractor is to keep on file a complete set of as-built drawings to be used for future service actions and future system enhancements.

D. Any and all custom furniture, carts, consoles etc. shall be documented in CAD form and provided with the as-builts.

E. Any and all wall plates, auxiliary panels etc. are to be provided as a part of the as-builts.

F. Manufacturer Documents - Provide three (3) sets. All equipment item manufacturer manuals shall be provided as a part of the contractors documentation package. All manuals are to be inserted into 3 ring binders. Also included in these binders are to be a complete equipment list of the serial numbers and manufacturer warranty information

2.3 COOPERATION WITH OTHER TRADES:

A. It shall be the responsibility of the Contractor to cooperate at all times, and to the fullest extent, with
all trades doing work in the building.

B. The Contractor shall be responsible to meet anticipated project schedules regardless of any and all local disputes.

2.4 INSTALLATION STANDARDS:

A. Qualified technicians shall perform all equipment, cabling and materials installation in a professional manner, in accordance with industry standards.

B. All equipment (permanent and portable) will be mechanically mounted as needed to prevent any unwanted movement (instability, vibration) during normal usage.

C. All mounting hardware and/or brackets shall be concealed wherever possible. The same type of hardware shall be used on all wall plates.

D. All equipment will be mounted with symmetry and center of gravity in mind.

E. All cabling on portable equipment will be dressed neatly and orderly with care taken that no cabling can be "snagged" when it is being moved.

F. All audio and control cabling will be installed within the NEC installation parameters for application and routing.

G. All cabling will be installed in a neat and orderly fashion.

H. Cabling:
1. All audio and control cabling will be installed within the NEC installation parameters for application and routing.
2. All cabling will be installed in a neat and orderly fashion.
3. Cabling will be secured and strain-relieved at all appropriate locations.
4. All cable connections to equipment will have maximum accessibility and cable labels will be visible.
5. Any piece of equipment will be removable without cutting wire ties or cable harnesses.
6. Service loops will be provided where necessary.
7. All cables run through plenum environments will be Teflon-jacketed in accordance with local fire codes.
8. Cables will not be gouged, bent, or otherwise damaged during installation or termination. Cables will not rest against any sharp metal edges. Grommets, plastic collars, or rubberized tape will be used where appropriate.
9. Cables and bundles will be dressed to look neat, orderly, and with the idea that a technician, who may be unfamiliar with the system, can find his or her way around the system with the aid of the documentation.

I. Equipment Rack Cabling Practices:
1. Internal equipment rack cabling shall conform to professional installation standards. All cables should be securely mounted within the rack to allow easy removal of the connector and visibility of the cable label. All cables shall be run to approach its connection point at the perpendicular, with a minimum length of 4" between the connector itself and the cable secured mounting. Cabling and connections shall include sufficient stain relief and lack of stress to eliminate potential intermittent break in proper signaling.
2. AC electric power strips shall be mounted on the left side of the equipment rack. All equipment power shall be derived from this central power location and not intermingled with signal or control cabling. High Voltage surge protection will be included where necessary to protect sensitive electronic equipment from harmful voltage spike.

3. Audio cabling shall be grouped in accordance to the signal level present in the specific wiring, paying careful attention to the separation of microphone level, line level and amplified signal levels.

J. Connection Plates:
1. All connection plates will be aluminum or stainless steel stock unless otherwise requested by owner.
2. All connectors will be isolated from AC power.

K. Cable Labeling:
1. All cables will be labeled the same at both ends.
2. Cable label designations will be clearly marked on schematic and block diagrams.
3. Labels shall be located 3 to 9 inches from connector.
4. Labels will be of 3M ScotchCode, Brady TM (or equivalent).

L. Wallplates:
1. Wallplates will be fabricated to match the architectural finishes.
2. Wallplates will be engraved with permanent lettering and numbering.
3. Final layout lettering will be approved by the Owner or their representative prior to fabrication.

M. Clean-up:
1. The Contractor will perform a general clean-up at the close of every work session. This will include clean-up of debris generated by the Contractor's technicians to the appropriate refuse containers on the particular floor on which they are working.
2. The Contractor will, at all times, keep hazards to minimum. Items to be left on site (if any) will be stored in an orderly and "out-of-the-way" manner and are not the responsibility of the Owner. The exception to this would be for items left in Owner approved locked storage areas.

2.5 OWNER TRAINING:

A. Training shall be provided to the owner for all installed systems. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system.
1. Each training session shall be a minimum of two hours.
2. Training shall consist of detailed operating functions and overall explanations of each systems capabilities and functionality.
3. A user's manual shall be used as a guide for training.
4. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of one hour.
5. Contractor shall be present for the first event during operation.
6. All training sessions shall be video-taped. The tape shall be turned over to the Owner for future reference.

2.6 WARRANTY:

A. All manufacturer warranties are to apply for all equipment provided in this contract. For a minimum, all equipment items shall carry a manufacturer warranty that is supported by the installing contractor for a period of one year from the date of acceptance by the owner.

B. Manufacturer warranties that provide more than one-year coverage shall also apply.

C. If the contractor is not an authorized dealer for equipment provided, it is the sole responsibility of that contractor to bear all costs of providing warranty services for those equipment items. During the first year of system operation the owner shall bear no costs for any warranty repairs, and the contractor shall provide 24-hour service response for the first year. Any contractor modified equipment items that may render the original manufacturer's warranty void shall be warranted 100% by the installing contractor for a period of one year.

2.7 PERFORMANCE TESTING:

A. The following details the minimum acceptable systems performance test procedures and results for audio and video systems performance.

1. Test Equipment Required:
   a. Variable Sine Wave Generator
   b. Sound Pressure Level Meter
   c. Distortion Analyzer
   d. Calibrated Microphone
   e. Real Time Spectrum Analyzer
   f. AC/DC Voltage/Ohm Meter
   g. Impedance Meter
   h. TEF Analyzer
2. Performance Standards: Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise mandated by the system applications, the following shall be the minimum performance specifications of the system.
   a. Signal/ Noise Ratio, 55 dB minimum, (including crosstalk and hum)
   b. Total Harmonic Distortion, 1% maximum from 40 Hz to 15,000 Hz.
   c. Frequency Response, 40 Hz to 15,000 Hz +/- 2 dB, (Program Playback)
3. Application of Performance Specification: The minimum performance specifications cited above shall apply equally to individual equipment components and to all inter-component connections, including but not limited to: distribution amplifiers, switchers, signal routers, patch bays. All point to point interconnections between sources and outputs shall meet the aforementioned system specifications.

END OF SECTION 271000

SECTION 271005 - STRUCTURED CABLING FOR VOICE AND DATA - INSIDE-PLANT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. New telephone and fiber services.

B. Cabling and pathways inside building.

C. Distribution frames, cross-connection equipment, enclosures, and outlets.

D. Grounding and bonding the telecommunications distribution system.

1.2 RELATED SECTIONS

A. Section 07 8400 - Firestopping.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Electrical system grounding and bonding.

C. Section 26 0534 - Conduit.

1.3 REFERENCES

A. EIA-310-D - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.

B. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cable for Use in General Purpose and LAN Communications Wiring Systems; Insulated Cable Engineers Association; 2002.

C. NFPA 70 - National Electrical Code; 2005.

D. TIA/EIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; Rev A, 1988 (R 2002).

E. TIA-492AAAB - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 1998 (R 2002).

F. TIA-526-14 - OFSTP-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Rev A, 1998(R2003).

G. TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev B, 2001; Addenda 1-7.

H. TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Rev B, 2001; Addenda 1-11.

I. TIA/EIA-568-B.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables; Rev B, 2000; Addendum 1.

L. TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces; Rev B, 2004.

M. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev A, 2002.

N. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.

O. UL 444 - Communications Cables; 2002.

P. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; 2001.

Q. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords; 2001.

R. UL 1863 - Standard for Communications-Circuit Accessories; 2004.

S. USDA RUS 345-83 - Gas Tube Surge Arrestors (PE-80); US Department of Agriculture; 1982.

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Storage and handling requirements and recommendations.
2. Installation methods.
3. 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).
4. Manufacturer Qualifications.
5. Installer Qualifications.
6. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 10 days prior to intended test date.
7. Field Test Reports.
8. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   a. Record actual locations of outlet boxes and distribution frames.
   b. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
   c. Identify distribution frames and equipment rooms by room number on contract drawings.
9. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 5 years' experience manufacturing products of the type specified.

B. Installer Qualifications: A company having at least 5 years' experience in the installation and testing of the type of system specified, and:

1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
2. Supervisors and installers factory certified by manufacturers of products to be installed.
3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for all work.
4. Employing experienced technicians for all work; show at least 3 years' experience in the installation of the type of system specified, with evidence from at least 2 projects that have been in use for at least 18 months; submit project name, address, and written certification by user.

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 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Replace defective product within a 20-year period after Date of Final Payment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cabling and Equipment:

1. Ortronics Company: www.ortronics.com.
2. Substitutions: See Section 01 6000 - Product Requirements.

2.2 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and hardware for voice and data communications, including cables, patch panels, racks cable management, labeling, and outlets.

1. Comply with TIA/EIA-568 and TIA/EIA-569, latest editions.
2. Cable pathways, conduit, and boxes will be provided under electrical contract. Cable Holders for cabling will be provided under this Contract.
3. 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.
4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
5. Main Distribution Frame (MDF): Centrally located support structure for terminating backbone cables, functioning as point of presence to external service provider.
   a. Locate main distribution frame as indicated on the drawings.

b. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.

6. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
   a. Locate intermediate distribution frames as indicated on the drawings.
   b. Patching from patch panels to District supplied electronics will be performed by District personnel.
7. Backbone Cabling: Cabling, and terminal hardware connecting intermediate distribution frames (IDF's) with existing main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
8. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".
9. Category 5E analogue POTS line cabling: From the MDF to each IDF provide 25-pair cables terminated on rack-mounted RJ45 style patch panels.

2.3 PATHWAYS

A. Provide all conduit, backboxes, sleeves, and cable tray pathways. All data and A/V cable holders are to be furnished and installed under the Electrical Contract. This includes all necessary supports to transport cabling from conduit stubs located above accessible ceilings to the Corridor cable tray system.

B. Data and A/V Cable Holders

1. Product: ECH-F/R cable holder manufactured by Hilti.
2. Substitutions: See Section 01 6000 - Product Requirements
3. Use: For support of all low-voltage and structured cabling from room locations to Corridor, and all other areas where cable tray is not present.

2.4 MDF RACKS AND ASSOCIATED HARDWARE

A. OPEN RELAY RACKS

1. Manufacturer: Ortronics or approved equal
2. Description: 19” floor mounted open relay rack, 7’0” height, with vertical cable management channels and covers, black. Rack: Ortronics #OR-MM6706. Provide horizontal Cable Managers, four per rack. Ortronics #OR-MM6HM62RU. Provide vertical cable management, Ortronics #OR-MM6VMS706.

B. PATCH PANELS

1. Fiber Optic Units (Backbone Fiber):
   a. Manufacturer: Ortronics or approved equal
   b. Description: Rack mounted fiber splice/patch panel. The unit shall be capable of splicing and patching up to 24 single-mode fibers with duplex SC plates. Provide one (1) Ortronics #OR-625MMC-24PL1B enclosures with adapter plates pre-loaded with 6-duplex SC connectors (12 single-mode fibers). Provide adequate plates suitable for patching up to 24 fibers per enclosure.
2. UTP Units:
   a. Manufacturer: Ortronics or approved equal.

b. Description: Rack mounted 110 to RJ45 patch panels for termination of station wiring and patching to Owner-supplied electronics. Provide Ortronics #OR-PHD6AU48, modular patch panel, Category 6A, 48-port, T568A/T568B configuration. Provide adequate ports to terminate all station cables, plus a minimum of 25% spare capacity. Provide two separate patch panels in the MDF for termination of the 50 pair telephone station cables (leaving future capacity).

2.5 IDF RACKS AND ASSOCIATED HARDWARE

A. OPEN RELAY RACKS

1. Manufacturer: Ortronics or approved equal
2. Description: 19” floor mounted open relay rack, 7’0” height, with vertical cable management channels and covers, black. Rack: Ortronics #OR-MM67067. Provide horizontal Cable Managers, four per rack. Ortronics #OR-MM6HM62RU. Provide vertical cable management, Ortronics #OR-MM6VMS706.

B. PATCH PANELS

1. Fiber Optic Units (Backbone Fiber):
   a. Manufacturer: Ortronics or approved equal
   b. Description: Rack mounted fiber splice/patch panel. The unit shall be capable of splicing and patching up to 12 fibers with duplex SC plates. Provide one (1) Ortronics #OR-625MMC-12PD1B enclosure with adapter plates pre-loaded with 6-duplex SC connectors (12 single-mode fibers). Provide adequate plates suitable for patching up to 12 fibers per enclosure.
2. UTP Units:
   a. Manufacturer: Ortronics or approved equal.
   b. Description: Rack mounted 110 to RJ45 patch panels for termination of station wiring and patching to Owner-supplied electronics. Provide Ortronics # OR-PHD610U48, modular patch panel, Category 6A, 48-port, T568A/T568B configuration. Provide adequate ports to terminate all station cables, plus a minimum of 25% spare capacity. Provide separate patch panels in the MDF for termination of the 25 pair telephone station cables (leaving future capacity).

2.6 INFORMATION OUTLETS

A. Data Stations:

1. Manufacturer: Ortronics or approved equal
2. Description: Category 6A, RJ45, 4-position SS wall plate. Refer to the drawings for number of active ports per station. Jacks shall be Ortronics OR-HDJ6A-88 (white), and icons for port identification.
3. Device plates shall be Ortronics 2601-37096-000. Plates shall accept up to four jacks in a single gang. Refer to the drawings for the number and type of modules per plate. Provide blank inserts as required to fill plate.

B. Cabling:

1. Fiber Optic Backbone Cables:
   a. Manufacturer: Berk-Tek, Superior Essex or approved equal.

b. Description: From the MDF to each new IDF, provide (1) 12-strand multimode cable. The multimode fiber shall be 50/125 m, Tight Buffered, plenum-rated, 12-strand, #PDP012FB3010/FS. All fiber-optic cables shall be run in fire-proof 1-1/4" orange innerduct.

2. UTP Cables
   a. Manufacturer: Berk-Tek, Superior Essex nCompass CAT 6A U/UTP cables or approved equal.
   b. Description: Four-pair, UTP, Enhanced Category 6A, plenum rated, 23 AWG. Provide LANmark-XTP UTP Plenum Category 6A, blue jacket.
3. Voice Feeder Cables
   a. Manufacturer: Berk-Tek, Superior Essex or approved equal.
   b. Description: Two 25-pairs inside plant Category 5E, plenum-rated cables run from the new wall-mounted 110-block cross connect field at the existing demark in the Mechanical Room to two new 48-port, RJ45 rack mounted patch panels in the MDF.
   c. Description: One 25-pair, inside plant, Category 5E, plenum-rated cable to be run from the MDF to each IDF. Cables should be terminated on a rack-mounted 48-port RJ45 patch panel at each IDF location, and a similar 48-port, RJ45 patch panel at the MDF location (for each IDF). Provide #10059632, gray cable.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA/EIA-568, TIA/EIA-569, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

3.2 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. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
   a. At Distribution Frames: 120 inches.
   b. At Outlets - Copper: 12 inches.
   c. At Outlets - Optical Fiber: 18 inches.
6. Copper Cabling:
   a. Category 5e/6: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
   b. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
   c. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.

7. Fiber Optic Cabling:
   a. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
   b. Support vertical cable at intervals as recommended by manufacturer.
8. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
9. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers. The labeling must conform to District standards. Contact the District Technology Department prior to the start of labeling to obtain the necessary identification standards.
   a. Cables: Install color coded labels on both ends.
   b. Outlets: Label each jack on its face plate as to its type and function, with a unique numerical identifier.
   c. Patch Panels: Label each jack as to its type and function, with a unique numerical identifier.
   d. Patch Cords: Label with jack identifier corresponding to initial installation.

3.3 TESTING

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.
5. The Installation Contractor shall test all horizontal distribution cables from the Wiring Distribution Closets to the workstation outlet. Testing shall be conducted in accordance with the guidance provided in EIA/TIA&ISO/EIC Standards. Only Category-6 testers (Those capable of testing category 6 cabling under 568-B.2) shall be used, that is, all test equipment used shall meet current Category 6 Standards. The Contractor shall provide written certification from the manufacturer that the test equipment meets these standards.
6. Minimum Test Requirements for Horizontal Distribution Cables: The Contractor shall perform a wire map test, and test for length, Attenuation, NEXT, Power Sum NEXT, ACR, Power Sum ACR, ELFEXT, Power Sum ELFEXT, Return Loss, Propagation Delay, and Delay Skew. Test results shall be evaluated against the information given below based on the Category 6 TIA 568-B.2 Standard.
7. Distribution Cable Testing:
   a. In the event of failure of Horizontal Cable testing the Contractor shall inspect the installed cable, termination, and failed test results to determine the probable failure cause. The Contractor shall take appropriate action to remedy and correct the situation. All failed cables shall be retested after corrective actions.
   b. If the Contractor has replaced termination hardware and cable as part of corrective action and the particular workstation drop still fails to pass testing, the Contractor shall bring the workstation drop to the attention of the Engineer for review and determination of the next action to be taken. The Engineer will determine at their discretion the next steps. The Contractor may advise the Owner based upon the perceived understanding of the failure.

8. Testing of Fiber Optic Backbone Cable:
   a. The installation Contractor shall test all fiber optic backbone cable. This testing also includes fiber optic cable between the Wiring Distribution Closets.
9. Minimum Test Requirements for Fiber Optic Backbone Cable:
   a. OTDR: Fiber Optic cables shall be tested in both directions using an OTDR.
   b. Power Meter: OTDR traces shall be made in both directions for all fibers tested.
   c. Power Meter:
      1) Fiber shall be tested in one direction using a light source and power meter.
      2) Acceptance criteria for the attenuation testing using the light meter shall be based upon the following: (Measured Length of Cable x Manufacturer Attenuation Rating) + (.3 dB x Number of Connector Pairs) + (.2 dB x Number of Splices) + (1 dB Tolerance Allowance) = Total End-to-End Span Attenuation including all intermediate spans, jumpers, and patch cables with all connectors and splices shall not exceed 11.5 dB maximum. OTDR and power meter tests shall be performed at the 850 nm and 1,300 nm nominal wavelength for the multimode fiber, and 1300nm and 1550 nm nominal wavelength for the single mode fiber.
   c. Test Configuration:
      1) The Contractor shall provide access jumpers needed to connect the test equipment to the fibers under test. Any access jumpers to be used with the light source and power meter shall be connected between the light source and power meter at the time the power meter is calibrated. The power meter shall be periodically recalibrated throughout the testing. The light meter manufacturer's documentation shall be used as a basis to determine the frequency of recalibration.
      2) During OTDR testing access jumpers (launch cable) shall be attached to both ends of the fiber under test to allow clear viewing of the connector pairs at each end of the fiber under test. The access jumper used between the OTDR and the fiber under test shall be sufficiently long to prevent the OTDR from saturating and going into shut down when viewing the first connector junction of the fiber under test.
      3) Actions in the Event of Failure of the Fiber Optic Backbone Cable:
         a) In the event of failure of Fiber Optic cable testing the Contractor shall inspect the installed cable, termination, and failed test results to determine the probable failure cause. The Contractor shall take appropriate action to remedy and correct the situation. All failed cables shall be retested after corrective actions. The Contractor shall systematically determinate the fiber cable, replace patch panel hardware, and replace fiber cable until the failed span passes testing.
         b) If the Contractor has replaced termination hardware and cable as part of corrective action and the cable still fails to pass testing, the Contractor shall bring the situation to the attention of the Owner for review and determination of what further action is to be taken. The Contractor may advise the Engineer as to their understanding of the failure and a recommended course of action.

10. 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 27 1100 – INSTRUMENTAL MUSIC SOUND SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

A. The Electrical Contractor, as part of this section, shall provide, install and test a complete sound reinforcement system as specified herein for areas indicated on the drawings.

B. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the sound reinforcement system.

1.2 SUBMITTALS

A. Submit the following in accordance with Conditions of Contracts and Division 1 specifications sections:

1. Audio functional
2. Rack elevations
3. Loudspeaker mounting details
4. Conduit riser
5. AV plate details
6. Cable pull schedule
7. Manufacturer equipment specification sheets

1.3 QUALIFICATIONS OF BIDDERS

A. The bidder shall be a firm with a minimum of 5 years of experience in the fabrication, assembly, and installation of audio systems of similar magnitude and quality as specified in these documents, and shall submit documentation to this effect with the bid return.

B. The bidder shall be I.C.I.A / A.V.S.P certified.

1.4 ALTERNATE EQUIPMENT

A. This equipment was selected to establish a standard of quality and performance. The contractor may offer substitutes for approval but the burden of proof of equality shall be with the contractor.

B. Pre-approval submittals shall contain a component-by-component comparison of all specification lines. Differences shall be clearly high-lited with the explanation and support data. Connection

drawings shall also be provided to establish how the substituted components will achieve the specified system design

C. The contractor shall provide any additional documentation, samples, or performance tests required by the Engineer in order to establish proof of equality with the specified equipment.

D. All substitutions shall provide equal of greater system performance and function. No substitute equipment shall be purchased or installed without approval by the Engineer.

E. Final approval of the substituted equipment shall be given after the system has been installed. Failure to meet the specification, as determined by the Engineer, shall result in the removal of the substituted equipment and the installation of the specified equipment without any additional cost to the owner.

F. When a piece of specified equipment has been discontinued by the manufacturer or is unavailable due to lack of inventory, the contractor may substitute the manufacturers recommended replacement without notice to the Engineer. If a piece of equipment is not replaced by a newer model with the same or better features and a different manufacturer can supply a piece of equipment that meets or exceeds the original equipment, the contractor shall notify the Engineer and submit the equipment cut sheets for approval.

1.5 EXCEPTIONS

A. Any and all exceptions to these specifications and related drawings must be made with the submission of the bid. In the absence of exceptions, the specifications and related drawings shall be binding in letter and intent on the successful bidder. It will also be understood that the bidder has examined the design and specifications in detail, and is prepared to take full responsibility for the performance of the complete installation as designed and specified.

1.6 SUB-CONTRACT INFORMATION

A. Any and all sub-contractors that a bidder plans to utilize for this project are to be listed with the references and qualifications in the bid submission. The successful bidder shall supervise all sub-contract work. Any and all sub-contract work is the complete and sole responsibility of the contractor.

1.7 SPECIFICATION INFORMATION REQUESTS AND QUESTIONS

A. Any requests for clarification shall be submitted to Mr. DJ Seibert of Snyder Hoffman Associates, 1005 West Lehigh Street, Bethlehem, PA, 18018, 610-694-8020, dseibert@snyderhoffman.com. All requests are to be made in writing and submitted no later than ten days prior to bid submission.

1.8 CERTIFICATIONS AND REPRESENTATIONS

A. Quality of materials: All equipment items and installation materials will be new. No previously owned, demonstrated or otherwise used items will be provided. Note that prior to equipment installation and on-site integration, all equipment items shall be performance tested and quality checked to insure full functionality of each equipment item.

B. Tax Statement Certification: The contractor certifies that all local, state, and federal taxes are separately listed in any price quotations.

1.9 QUALITY ASSURANCE

A. All equipment and materials provided for this contract are to be new and shall meet or exceed the latest published specification of the manufacturer for that item.

B. All equipment shall be UL listed or equivalent.

1.10 NOT IN CONTRACT

A. Some equipment related to the audio system will be provided under the Electrical Contract. Unless otherwise indicated in these specifications or related drawings, these will include the following:

1. All electrical breaker / load panels.

PART 2 PRODUCTS

2.1 EQUIPMENT DESCRIPTION

A. System Electronics:

1. The Instrumental & Music classrooms shall be provided with a complete locally controllable audio system. All equipment shall conform to the manufacturer's latest published specifications in feature and function both physically and electronically whether or not those specifications are delineated herein. The manufacturer's latest published specifications shall be considered as part of this text. Quantities shown on the contract drawings.

2. Mixer / Amplifier: Provide (2) Ashly mXa-1502 or equal. The unit shall consist of a two-channel, multi-mode Class D amplifier capable of driving 2 Ohm loads at full power. Each channel shall have selectable output mode of Low Z, 25V, 70V, or 100V with a maximum rated output power of 150W per channel in all modes and will be bridgeable to deliver a

single channel power output of 300W @4 or 8 Ohms. There shall be an automatic but defeatable sleep mode consuming <1W. A switch-mode power supply with active Power Factor Correction (PFC) shall auto-detect 100 – 240VAC mains and operate from 70 – 270VAC.

The unit shall have a multi-channel, user-programmable DSP capable of mixing 8-mic/line inputs, plus 4 stereo line inputs into 4 independent outputs. The mic inputs shall each provide 48V phantom power, switchable per channel via software. Each Input DSP channel shall have up to six assignable DSP function blocks, which shall be arrangeable in any order by the user and which may include: Gain, VCA Gain, DCA Gain, Remote Gain, 10-band PEQ, 31-band graphic EQ, HPF, LPF, Compressor, Auto-Leveler, Brick Wall Limiter, Gate, Feedback Suppressor, Delay, Signal Generator & Meter. DSP functions for the stereo channels shall also be stereo. Each Input shall allow routing to up to four mixers, each of which provides: Gain, Meter, Auto-Mix & Ducker assignable to each input channel. The unit's Output DSP consists of four channels, each having six assignable blocks, also arrangeable in an order by the user and which may include: Gain, VCA Gain, DCA Gain, Remote Gain, 10-band PEQ, 31-band graphic EQ, HPF, LPF, Compressor, Auto-Leveler, Brick Wall Limiter, Gate, Ambient Noise Compensation, FIR Filters, Delay, X-Over (2, 3 & 4-way), Signal Generator & Meter. Each Output Channel shall allow receiving a signal from any one of the four mixers as determined by the user. The four Output Channels shall feed the two amplifier channels (AMP OUT 1 & AMP OUT 2) and the two AUX Line Out Channels (AUX OUT 1 & AUX OUT 2) respectively in a fixed configuration.

The unit's DSP shall also incorporate an RTC (Real-Time Clock), which can be synchronized to an external clock source (such as a PC or NTP server). The unit shall have a built-in scheduler (driven by the RTC), which can be programmed by the user for various timed operations, such as: power-on/standby, preset recall, sub-preset recall, source select, channel mute/unmute & channel gain adjustment (±). The unit's DSP shall be managed by an internal web-server and database and controlled by a networked PC or tablet device which is browser-enabled. It shall therefore not be required that a separate software application be installed on a PC or other device, in order for the user to access DSP functions.

Mechanical: The front panel shall have LEDs indicating Input Signal (green), Clip/Mute (Red), Current (Green) and Temperature (Yellow) for each power channel and will also have global LEDs for indicating the amp's Protect (Red), COM (Green), Disable (Yellow) and Sleep (Blue) modes. The front panel shall have four momentary buttons that may be user-programmed to perform preset recall or source-select functions. There shall also be a round momentary Power button with a white LED backlight to indicate the amp's "ON" status. The front grille shall be composed of high-impact resin and shall be perforated to allow proper airflow.

The unit's rear panel shall have 8-Balanced Mic/Line inputs each with removeable 3.5mm Euroblock connectors and will also have 4-stereo unbalanced Line Inputs, each with dual RCA phono connectors. The unit will have two balanced line (AUX) outputs with removeable 3.5mm Euroblock connectors and two powered speaker outputs, which shall have 7.62mm Euroblock connectors. The unit shall have 8-adressable GPI & 2-GPO, 2-

Amplifier Fault, 3-VC Remote, 1-Serial Data and 1-Amplfier Standby ports, all with removeable 3.5mm Euroblock connectors. There shall be a DIP-switch pair for each power amp allowing selection of amplifier mode (Low Z/25/70/100V). The unit shall be networkable and shall have an RJ45 100/1000BaseT Ethernet jack. The unit shall have a detachable IEC power receptacle capable of working with region appropriate power cables.

The unit shall be housed in a 1U metal chassis, with front and side perforations to allow proper cooling from the variable-speed fan. The unit shall weigh <11.3 lbs. (5.1kg) and shall measure 19" W x 1.75"H x 14.54" D (483mm x 45mm x 369mm) and mount in a standard 19" rack. There shall be a five-year warranty for units purchased in the US.

3. Media Player with Bluetooth Receiver and AM/FM Tuner: Provide Denon Pro DN-300Z or equal. The media player shall feature:
    1. Super-fast loading, slot-in CD mechanism
    2. Supports removable USB thumb and HDDs, SD/SDHC cards
    3. Wireless audio playback from devices via Bluetooth
    4. Plays CD, MP3, WAV, and AAC files
    5. 3.5mm Aux-in for audio playback of other devices
    6. AM/FM Tuner w/ dedicated audio out for multi-room use
    7. Unbalanced combi audio output
    8. 10-key direct track access
    9. Random, Repeat One, Repeat All, and continuous play modes
    10. Folder only and All play modes
    11. IR controllable with included, compact remote
    12. 1RU chassis with removable rack ears
    13. Detachable IEC-weighted AC inlet
    14. 100-220v switching power supply

    Number of channels: 2 (stereo), 1 (mono), Audio frequency characteristics: 10Hz – 20kHz (+ 1.0 dB), S/N ratio: More than 95 dB (A-Weighted), Total harmonic distortion: Less than 0.01%, Dynamic range: More than 85 dB, Channel separation: More than 80 dB.

    Bluetooth: Version 3.0, Output class: Class 2, Support Codec: SBC, MP3, AAC, aptX, Support Profile: A2DP, AVDTP 1.0, AVCTP 1.3, AVRCP 1.0, SSP.

    Tuner Section: FM AM, Receiving range; North and South America: FM- 87.50 MHz– 107.90, AM- 520 kHz – 1710 kHz, Sensitivity: 30 dBµV / m 60 dBµV / 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 kΩ/kohms, Output level: 2 Vrms / at 10 kΩ/kohms load.

    Input Section: AUX-in: Type: TRS terminal (Ø 3.5), Input impedance: Over 10kΩ/kohms, Maximum input level: 1 Vrms, Maximum output level: 3 Vrms

4. Microphones and cables: The following microphones, cables, and stands shall be provided for various assembly purposes:
    a.
    b. Provide (4) Shure SM58-CN cardioid, dynamic microphones. (2 for each room)
    c. Provide (4) Shure SM57 Dynamic instrument microphones. (2 for each room)
    d. (12) XLR male to XLR female shielded microphone cables, (25) feet in length.
    e. (4) Ultimate MC-77B stands or equal. Stands shall feature one-handed height adjustment, weighted and stackable bases, telescoping height of 39" to 64", weight shall be eight lbs and finished in black. (2 for each room)

5. LOUDSPEAKERS

Community/Biamp D8 loudspeakers (See plans for locations and quantities): The loudspeaker system shall be a two-way, full-range ceiling mount system with an 8-inch low frequency transducer with patented Carbon Ring Cone Technology™ and a coaxially mounted 1.25-inch exit high frequency compression driver. The drivers shall be connected to an integral crossover with a crossover frequency of 1.3 kHz, with a self-resetting solid state circuit breaker for driver protection. The paintable loudspeaker baffle shall be constructed of UL 94V-0 rated ABS material and include Twist-Assist™ face retainer tabs for easy insertion into the back cans. A paintable steel grille with a durable white powder coat finish shall be included.

The back can provided with the ceiling loudspeaker system, shall be constructed of corrosion-resistant zinc plated steel featuring spring loaded Drop-Stop™ installation assistant tabs. The back can shall include a recessed termination box with a removable locking connector with screw terminals for secure wire termination with "loop through" ability. Strain relief will be provided by a clamping mechanism for use with plenum rated cable or conduit.

The system shall have an amplitude response of 80 Hz to 20 kHz (+/- 5dB) and a low impedance (8 ohm) input capability of 35V RMS. The sensitivity at 1W/1m shall be 95 dB (120 Hz to 12.5 kHz, 1/3 octave bands). The loudspeaker system shall have a conical coverage pattern of 115 degrees from 500 Hz to 6 kHz. The nominal system impedance shall be 8 ohms (in low impedance setting).

The system shall be equipped with a 120W high performance autoformer for use in 70.7V or 100V distributed audio systems, with 120W, 60W, 30W and 15W taps available in 70.7V distributed systems (120W, 60W and 30W taps available in 100V distributed systems). An easily accessible front-face tap selector switch located on the front baffle, which is concealed by the supplied removable grille, shall be available for selecting autoformer and low impedance settings.

A snap-on C-Ring supporting plate and two tile support bridge rails shall be included. The loudspeaker system shall have a bezel diameter of 13.209 inches (335.5 mm), a can depth of 8.166 inches (207.4 mm) and weigh 16.4 lbs (7.4 kg). There shall be available an

optional New Construction Bracket for installing the loudspeaker system in new construction before drywall or plaster is put into place. An optional pair of 48" (1219mm) channel rails shall also be available to mount the loudspeaker in larger ceiling grids.

6. Rack Enclosures:
   a. Provide Atlas Sound #AWR3W recessed, tilt out rack or equal. Provide rack with enough space to accommodate all equipment that will be installed in the rack for the system specified including space for rack venting. Audio rack shall accommodate equipment to a standard rack width of nineteen inches.

   b. Provide all necessary mounting hardware for equipment and wiring.

7. Provide stainless steel microphone / line input plates for connection of microphones and line level equipment. Quantity, location, and type of plates are listed on the drawings. The microphone / line input plates shall be terminated and properly marked to the audio rack. All plates shall be engraved as described on the drawings. Silk screen identification will not be accepted. Face plate color shall be stainless steel with black engraved letters.

2.2 CONTRACTOR'S DOCUMENTATION:

A. As-Built Drawings. Provide three (3) sets. The Contractor shall provide complete point to point wiring schematics of all system components including audio, video and control. Drawings shall include cable numbering, equipment locations, jacks, input /output plates etc.

B. A final set of as-built drawings shall be provided within 10 working days of acceptance by the Owner. Two copies of this as-built information shall be provided one to the Owner and one to the Engineer. As-builts shall be provided on reproducible media, and one CD Rom.

C. The Contractor is to keep on file a complete set of as-built drawings to be used for future service actions and future system enhancements.

D. Any and all custom furniture, carts, consoles etc. shall be documented in CAD form and provided with the as-builts.

E. Any and all wall plates, auxiliary panels etc. are to be provided as a part of the as-builts.

F. Manufacturer Documents - Provide three (3) sets. All equipment item manufacturer manuals shall be provided as a part of the contractors documentation package. All manuals are to be inserted into 3 ring binders. Also included in these binders are to be a complete equipment list of the serial numbers and manufacturer warranty information

2.3 COOPERATION WITH OTHER TRADES:

A. It shall be the responsibility of the Contractor to cooperate at all times, and to the fullest extent, with
all trades doing work in the building.

B. The Contractor shall be responsible to meet anticipated project schedules regardless of any and all local disputes.

2.4 INSTALLATION STANDARDS:

A. Qualified technicians shall perform all equipment, cabling and materials installation in a professional manner, in accordance with industry standards.

B. All equipment (permanent and portable) will be mechanically mounted as needed to prevent any unwanted movement (instability, vibration) during normal usage.

C. All mounting hardware and/or brackets shall be concealed wherever possible. The same type of hardware shall be used on all wall plates.

D. All equipment will be mounted with symmetry and center of gravity in mind.

E. All cabling on portable equipment will be dressed neatly and orderly with care taken that no cabling can be "snagged" when it is being moved.

F. All audio and control cabling will be installed within the NEC installation parameters for application and routing.

G. All cabling will be installed in a neat and orderly fashion.

H. Cabling:
1. All audio and control cabling will be installed within the NEC installation parameters for application and routing.
2. All cabling will be installed in a neat and orderly fashion.
3. Cabling will be secured and strain-relieved at all appropriate locations.
4. All cable connections to equipment will have maximum accessibility and cable labels will be visible.
5. Any piece of equipment will be removable without cutting wire ties or cable harnesses.
6. Service loops will be provided where necessary.
7. All cables run through plenum environments will be Teflon-jacketed in accordance with local fire codes.

8. Cables will not be gouged, bent, or otherwise damaged during installation or termination. Cables will not rest against any sharp metal edges. Grommets, plastic collars, or rubberized tape will be used where appropriate.
9. Cables and bundles will be dressed to look neat, orderly, and with the idea that a technician, who may be unfamiliar with the system, can find his or her way around the system with the aid of the documentation.

I. Equipment Rack Cabling Practices:
1. Internal equipment rack cabling shall conform to professional installation standards. All cables should be securely mounted within the rack to allow easy removal of the connector and visibility of the cable label. All cables shall be run to approach its connection point at the perpendicular, with a minimum length of 4" between the connector itself and the cable secured mounting. Cabling and connections shall include sufficient stain relief and lack of stress to eliminate potential intermittent break in proper signaling.
2. AC electric power strips shall be mounted on the left side of the equipment rack. All equipment power shall be derived from this central power location and not intermingled with signal or control cabling. High Voltage surge protection will be included where necessary to protect sensitive electronic equipment from harmful voltage spike.
3. Audio cabling shall be grouped in accordance to the signal level present in the specific wiring, paying careful attention to the separation of microphone level, line level and amplified signal levels.

J. Connection Plates:
1. All connection plates will be aluminum or stainless steel stock unless otherwise requested by owner.
2. All connectors will be isolated from AC power.

K. Cable Labeling:
1. All cables will be labeled the same at both ends.
2. Cable label designations will be clearly marked on schematic and block diagrams.
3. Labels shall be located 3 to 9 inches from connector.
4. Labels will be of 3M ScotchCode, Brady TM (or equivalent).

L. Wallplates:
1. Wallplates will be fabricated to match the architectural finishes.
2. Wallplates will be engraved with permanent lettering and numbering.
3. Final layout lettering will be approved by the Owner or their representative prior to fabrication.

M. Clean-up:
1. The Contractor will perform a general clean-up at the close of every work session. This will include clean-up of debris generated by the Contractor's technicians to the appropriate refuse containers on the particular floor on which they are working.
2. The Contractor will, at all times, keep hazards to minimum. Items to be left on site (if any) will be stored in an orderly and "out-of-the-way" manner and are not the

responsibility of the Owner. The exception to this would be for items left in Owner approved locked storage areas.

2.5 OWNER TRAINING:

A. Training shall be provided to the owner for all installed systems. A minimum of two separate training sessions shall be conducted upon owner acceptance of the system.
   1. Each training session shall be a minimum of two hours.
   2. Training shall consist of detailed operating functions and overall explanations of each systems capabilities and functionality.
   3. A user's manual shall be used as a guide for training.
   4. A follow up training within 60 days of Owner acceptance shall also be provided. This session to be a minimum of one hour.
   5. Contractor shall be present for the first event during operation.
   6. All training sessions shall be video-taped. The tape shall be turned over to the Owner for future reference.

2.6 WARRANTY:

A. All manufacturer warranties are to apply for all equipment provided in this contract. For a minimum, all equipment items shall carry a manufacturer warranty that is supported by the installing contractor for a period of one year from the date of acceptance by the owner.

B. Manufacturer warranties that provide more than one-year coverage shall also apply.

C. If the contractor is not an authorized dealer for equipment provided, it is the sole responsibility of that contractor to bear all costs of providing warranty services for those equipment items. During the first year of system operation the owner shall bear no costs for any warranty repairs, and the contractor shall provide 24-hour service response for the first year. Any contractor modified equipment items that may render the original manufacturer’s warranty void shall be warranted 100% by the installing contractor for a period of one year.

2.7 PERFORMANCE TESTING:

A. The following details the minimum acceptable systems performance test procedures and results for audio and video systems performance.

   1. Test Equipment Required:
      a. Variable Sine Wave Generator
      b. Sound Pressure Level Meter
      c. Distortion Analyzer
      d. Calibrated Microphone
      e. Real Time Spectrum Analyzer
      f. AC/DC Voltage/Ohm Meter
      g. Impedance Meter

h. TEF Analyzer

2. Performance Standards: Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise mandated by the system applications, the following shall be the minimum performance specifications of the system.
   a. Signal/ Noise Ratio, 55 dB minimum, (including crosstalk and hum)
   b. Total Harmonic Distortion, 1% maximum from 40 Hz to 15,000 Hz.
   c. Frequency Response, 40 Hz to 15,000 Hz +/- 2 dB, (Program Playback)
3. Application of Performance Specification: The minimum performance specifications cited above shall apply equally to individual equipment components and to all inter-component connections, including but not limited to: distribution amplifiers, switchers, signal routers, patch bays. All point to point interconnections between sources and outputs shall meet the aforementioned system specifications.

END OF SECTION 271100

SECTION 275134 – INTERCOM AND PA

PART 1 - GENERAL

1.1 GENERAL

A. Where applicable visit the site, verify all existing items shown on plans or specified, and be familiar with the working conditions, hazards, and local requirements involved. Submission of bids shall be deemed evidence of such visit. All proposals shall take these existing conditions into consideration before bidding.

B. All materials, unless otherwise specified, shall be new, free from any defects, and of the best quality of their respective kinds. All like materials used shall be of the same manufacture, model, and quality, unless otherwise specified.

C. Manufacturer's names are listed herein to establish a standard. The products of other manufacturers will only be acceptable if approved by the specifying architect 10 days prior to bid. These products must: be of equal or better quality than the features specified herein, will serve with equal efficiency and dependability, and satisfy the purpose for which the items specified were intended.

D. Contractor shall do all necessary cutting and drilling of present walls, floors, ceilings, etc., for the installation of new work; but no structural work shall be cut, unless specifically shown on drawings and/or approved by the Owner. All exposed building surfaces damaged by installation or removal of electrical work shall be patched and finished in the same materials and manner as adjacent areas by this Contractor.

E. Contractor shall co-ordinate their work with the Owner for times which changeover, removal of existing equipment, and new connections of existing systems can be completed.

1.2 QUALITY ASSURANCE

A. Manufactures: Firms regularly engaged in manufacture of integrated communication systems, time keeping systems, and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for no less than five years.

B. Installer's Qualifications: Firms with at least five years of successful installation experience with projects utilizing integrated communications systems and equipment similar to that required for this project.

C. All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

D. The Contractor shall be an established communications and electronics Contractor that has had and currently maintains a locally run and operated business for at least five years. The Contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.

E. The Contractor shall show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor shall maintain at their facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

F. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and experience in the industry. The Contractor shall have attended the manufacturer's installation and service school and upon request must show proof of attending such a school.

1.3 SCOPE OF WORK

A. Furnish and install all materials, labor, equipment, permits, etc., to provide communications system as described herein and illustrated on the drawings for a complete operating system.

B. All manufactured articles, material, and equipment shall be applied, installed connected, erected, used, cleaned, adjusted, and conditioned as recommended by the manufacturers, or as indicated in their published literature, unless specifically herein specified to the contrary.

C. All work shall be performed by competent professionals and executed in a neat and professional manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials. At completion, the installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of this portion of work shall be removed from the premises.

D. Program the operational characteristics matching the operation described herein, adjusting for call routing, transfers, priorities, and volume levels.

E. Remove all existing conduit, wire device, etc., being abandoned due to relocation.

F. The Contractor shall provide a minimum of eight hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. Operator Manuals and User Guides shall be provided at the time of this training.

1.4 SUMMARY

A. Work Included. The scope of work of this section consists of the design, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances, and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:

1. Supervised Network Intercom and Paging System, including but not limited to:

    a. Supervised network amplifiers, back boxes, and all equipment, cabling and support required to interface the public address system to the Owner's telephone system via SIP Trunk Interface.

b. Supervised network system speakers, and ceiling mounted speakers, wall mounted horn, both interior and exterior.
c. Cabling to support the Public Address System (NOTE: category 5/6 cable must conform to Owner guidelines. Coordinate with Owner prior to submission for approval).
e. Supervised network PA override signal to local sound systems. Coordinate with 27 40 00 contractor.
f. Supervised network emergency messaging display capable of receiving and scrolling up to 64 character long custom messages without affecting or replacing display of time segments, and coded messages simultaneous with plain text message (displacement to time segments permissible for coded messages).
g. Interactive Graphical User Interface (IGUI) supporting a pictorial view of architectural room locations on a map, and controlling intercom functions including zone or all page, dynamic zone assignments, answering intercom call-ins, selecting and distributing program sources to any and all zones. IGUI will also annunciate, locate and indicate loss of communication to all supervised network devices including speakers, amplifiers, emergency messaging display, and notification switches.
h. Emergency communication shall be initiated by the local console or from a centrally located district office via a District Wide Emergency Communication platform (included/not included in this contract). Emergency communication shall include but not be limited to, pre-recorded audio, live audio, emergency textual message display activation, computer pop-up notification, SMS Text message, and email.

1.5 SUBMITTALS

A. Submit the shop drawings, product data, and quality control submittals specified below at the same time as a package.

B. Shop Drawings: Composite wiring and/or schematic diagrams of the complete system as proposed to be installed. Drawing shall include relative position of all major components, typical connections, field components, accessories, and cable types.

C. Product Data: Include catalogue data sheets, manufacturer’s default specifications, user operation guides, and bill of materials.

D. Quality control shall include the following:
1. Name, address, and telephone number of the nearest fully equipped service organization.
2. Submit a certificate of completion of installation and service training from the system manufacturer.
3. Submit a list of comparable completed projects. Furnish the name, address, telephone number, and contact name of end user.

PART 2 - PRODUCTS

2.1 RACEWAYS AND CABLES

A. Electrical work will conform to the National Electric Code and applicable local ordinances.

B. All 125-volt electrical conductors shall be installed in galvanized electrical metallic tubing with compression type fittings and couplings, minimum 1/2" size conduit.

C. All low-voltage wires and cables concealed in walls shall be run in EMT conduits from flush outlet boxes to above accessible ceilings. Provide conduits where cables penetrate firewalls above ceilings.

D. All EMT entering boxes shall be served with insulating throat connectors and locknuts.

E. No raceway shall be located in proximity of hot water lines or excessive heat.

F. Where raceways cannot be run concealed in walls, use Wiremold Series surface raceway complete with all fittings, box extension rings, and required accessories. Co-ordinate routing of surface raceways with the Owner.

G. Use Cast "C" clamps, "U" straps, or ring hangers attached to rods, and/or brackets fastened to structure.

H. No perforated straps or tie wires permitted for supporting raceways.

I. Use wire ties for supporting low voltage cables run concealed above ceilings. Do not run cables loose on ceiling tiles. Support from structure above. Group cables in bundles.

J. Tie mounts, plates, and anchors shall be used.

K. Ground all electrical apparatus in accordance with the National Electric Code.

2.2 GENERAL DESCRIPTION OF NETWORK INTERNAL COMMUNICATION SYSTEM

A. Supply and install a complete supervised network based intercom system. Field wiring shall be CAT 5E or CAT 6 cable, control wiring for power distributions and very long runs, and utilize an optional fiber backbone (when distances exceed normal Ethernet limitations). All station equipment shall utilize standard RJ-45 modular connections. All remote devices utilizing standard structured cabling shall be capable of PoE (Power over Ethernet) or power supplied within the CAT 5E or CAT 6 cable jacket. Wiring shall be capable of either being installed in conduit or cable trays, where shown on the plans

B. The system shall be capable of interconnecting with the building LAN (Local Area Network). This connection shall be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection per station to accomplish all intercom operations. Ethernet ports and associated network switches that are required to connect any intercom devices will be provided by the OWNER.

C. Provide a separate circuit for each room and administrative office so each room, speaker, amplifier, and emergency messaging display can be individually addressed.

D. Overall intercom communications network shall utilize Ethernet or VoIP communications between all major components: administrative consoles, intercom stations, amplifiers and individual paging speakers, and network switches. Systems not utilizing Ethernet or VoIP communications protocol to each end-point device will not be acceptable. Systems not capable of supervising all networked devices including network amplifiers, network speakers, notification switches, and emergency messaging display will not be acceptable.

E. The network shall support a VLAN configuration to separate activity in the intercom system from other in building LAN traffic. In locations where the supervised network communications system will be considered as part of the facility's life safety systems, a dedicated and isolated network shall be required.

F. The system shall interface to the facility's PBX via SIP trunk connectivity.

G. The system shall support fault monitoring and trouble notification features. When a fault monitoring device detects a fault, devices will notify of trouble should they be capable and configured to do so. Faults shall include but not be limited to devices:
   1. Disconnecting from the network
   2. Having invalid configuration
   3. Having mismatched firmware

2.3 DESCRIPTION OF NETWORK INTERCOM / PA / MESSAGING FEATURES

A. The system specified is based on the Telecor eSeries Supervised Network based Communications System providing at least the features and functions outlined below. It shall be installed and programmed by a local authorized and certified Telecor dealer.

B. The system shall utilize a decentralized network structure not requiring any head-end equipment, central server, or any other control hardware to maintain system operation. Systems utilizing centralized electronics and subject to a single-point-of-failure (power supply, CPU, server, power, etc.) shall not be accepted unless the system has 100% duplication of all centralized operating equipment running concurrently and can automatically take over, including up to the minute programming configuration in the event of a failure of the main system head-end electronics or any required, centralized electronics required to make the system fully operational. Systems that are not based on decentralized structure or systems that do not provide 100% duplication of head-end or systems that operate in a “down-graded” operational mode as the result of a centralized failure are not acceptable.

C. All station devices shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power-over-Ethernet network switch, all networked devices shall be immediately operational and as applicable shall be able to place or receive calls and pages from Stations as well as page all devices in the network. Consoles, intercom stations, emergency displays, or speakers connected to the network shall not require any network configuration or administration to function.

D. Each Intercom Station, Loudspeaker, message display, shall be assignable to all or any combination of Unlimited Paging, Program Distribution or Time Zones in the system.

F. Speech shall be transmitted in the frequency range from 50 Hz to 7 kHz and shall use a maximum of 128 kbps of bandwidth during a call. In order to assure maximum intelligibility, all system audio shall be HD Audio as defined in Intel(TM) High Definition Audio Specifications, June 17, 2010.

G. Intercom communications between consoles and system devices shall be non-blocking with no channel restrictions or limitations (other than network capacity) to the number of simultaneous conversations at any time between pairs of intercom stations, intercom station to console, console to console, console to speaker or zone of speakers, program source to a speaker or zone of speakers, or bell tones to a speaker or zone of speakers regardless of number of stations or consoles.

H. Any and all device shall have the ability to have its programming downloaded, individually or simultaneously via the network. Programming shall be downloadable in a series of human readable, industry standard comma-separated values (CSV) files that can be saved and edited using common spreadsheet applications. Consoles, intercom stations, displays, and speakers residing on a network shall have the ability to update their programming, simultaneously from a CSV file. Furthermore, all devices shall also have the capability to be configured directly, such that device numbers, names, zones, and call-in destinations can be altered in real time without the uploading or downloading of their programming. System shall be capable of uploading firmware updates to all device classes simultaneously, via the network, without the requirement of tools, by authorized technician or qualified facility technician or representatives.

I. Audio communications between all devices shall be accomplished with latency values of a maximum of 0.1 seconds and connection times of 0.01s for 1 to 500 speakers.

J. The system shall support a minimum of 50 channels of simultaneous duplex communication paths on the intercom system LAN, plus a minimum of 10 simultaneous duplex channels for PBX integration.

K. The system shall be capable of routing calls from the Public Switched Telephone Network (PSTN) into any classroom, zone or the entire school via the District's SIP enabled Telephone System. This shall allow for remote monitoring and two-way voice communications from outside the facility to classrooms as well as paging into areas of the school. Additional features shall include:
   1. The ability to place call-ins from classroom call stations to SIP Telephones
   2. The ability to initiate calls from SIP Telephones to eSeries Classroom Speakers.
   3. The ability to initiate zone and all call paging announcements from SIP Telephones to eSeries Speakers throughout the facility.
   4. The ability to make outside calls from Administrative Consoles to the PSTN via the Districts Phone System.

L. The System shall allow users to configure multiple schedules per school, with an unlimited number of programmable events in each schedule. Each Event shall sound a user selectable tone and play a user provided audio file or an external audio source. In addition a textual message shall be able to be programmed to be displayed at associated message displays throughout the school. All scheduling assignments shall be performed via a simple to use Graphical User Interface (GUI) from a non-dedicated PC residing in the School. Programming shall also be accomplished from a non-dedicated PC at the District Office. The following features and functions shall be provided. Systems that cannot provide these, shall not be acceptable.
   1. The system schedules shall facilitate the requirements of combined facilities (e.g. elementary and middle schools in a common building) where multiple schedules running concurrently would be required.
   2. Each event shall play any of the available tones, audio files or audio sources provided.

Events shall be directed to any one or more Time Zones in the systems.

3. Events shall include textual messages to message displays. These shall be formatted as fixed, flashing or scrolling displays that can include up to 200 characters in length.
4. Time Tones may be manually activated from Administrative Consoles or selected SIP phones residing on the school IP-PBX.

M. The System shall be capable of automatically distribute SMS and email notifications to relevant staff members when an emergency event is occurring at the facility. Notifications shall be distributed to user alert devices such as mobile phones and smart devices. Mobile phones shall receive the notifications as SMS messages while smart devices shall receive email messages. Emergency events include:
1. The activation of emergency-themed element icons on a PC GUI (e.g., Lockdown, Evacuate, etc.)
2. Emergency Calls placed from Call Stations located in room locations.

N. The system shall automatically distribute SMS and email notifications to appropriate technical support staff in the event that the system is experiencing a fault.

2.4 SUPERVISED NETWORK ADMINISTRATIVE CONTROL CONSOLE

A. The Supervised Network Administrative Control Console (subsequently referred to as Console) shall be a Telecor model e300 or approved equal. The Console shall be supervised and allow the operator to establish two-way communications with an intercom station, talkback speaker, or another Console using the handset or speakerphone. VOX functioning shall be automatically enabled when the handset is used. The Push-to-Talk button shall toggle the Console between talk and listen mode when the speakerphone is used. The Console shall provide a 2-line by 20-character LCD display. The display shall be able to be tilted at different angles for optimum viewing. When there are no active calls, the display shall show the Console name and dial number. If a time server is connected to the network, the display shall also show the time and date.

B. Incoming calls to a Console shall show the originating station dial number and name on the Console display. Calls shall be displayed in the order they are received. The operator shall be able to scroll through the list of calls and answer them out of sequence. Emergency call-ins shall be distinctly annunciated both visually and audibly.

C. The Console shall allow call-ins to be forwarded to another Console, or for calls to be put on hold or transferred to another Console location. Additionally, call-ins or calls shall be forward/transfer-able to PBX telephone extensions via a SIP trunk interface.

D. The Console shall be able to select remote audio sources connected at any location on the local area network, and distribute the audio broadcast from the source to all speakers in a facility or to selected areas such as a speaker zone or a selection of speakers. The Console shall be capable of audio source verification by attendant prior to page zone activation. In this manner attendants shall be able to listen to the audio source locally, including listening to pre-recorded announcements, prior to system broadcast.

E. The Console shall be able select a tone or a pre-recorded announcement and broadcast the tone or announcement to all facility speakers or to select areas, such as a speaker zone or a selection of speakers.

F. The Console shall be equipped with digital volume control that shall allow for the separate adjustment of the speaker listen and handset listen volumes. The levels for intercom listen, tones, and program distributions shall be independently adjusted and stored in memory.

G. The system shall allow user programming of alphanumeric architectural room names and numbers. The Console shall be capable of using 1 to 7 digit sequences for dial out and call-in identification, and shall display station numbering, station name, and call-in priority.

H. The end-user shall be allowed to choose and determine the number and location of Consoles. The end-user shall not be limited by pre-set manufacturer limitations of the number of Consoles required by this project; allowing for unrestricted future expansion. Consoles may be added at any time. Consoles added by the end-user that exceed the engineered design for this project shall be at owner's expense. Communication between consoles or consoles and intercom stations or rooms shall not be inhibited by channel number restrictions.

I. The Console shall be capable of displaying room statuses such as Privacy and Do Not Disturb and shall have the ability to override any status limiting communication between the Console and a station with Privacy or Do Not Disturb status activated. Temporary override shall not interfere with continued activation of Privacy and Do Not Disturb after communication has been established and electively terminated.

J. The Console shall support an optional desktop microphone that shall be a Telecor model MCC-PM-MA or approved equal. The desktop microphone shall provide additional buttons, indicators and circuitry to control the Console during intercom and paging operations. The desktop microphone shall feature a gooseneck microphone that includes a ring LED around the microphone to indicate when the microphone is live. The desktop microphone shall connect to the Console via CAT5 or higher cable with RJ-45 terminations. The desktop microphone shall feature pushbuttons for listen audio volume control, Push to Talk, Call Cancel, forwarding Console call-ins to another pre-programmed Console, and zone paging. These push buttons shall behalf identically to their Console counterparts. The desktop microphone shall also feature a 2.5mm jack to support a headset. A headset pushbutton shall toggle between directing audio to the desktop microphone speaker and the connected headset. Also featured shall be a ¼" phono jack to support a footswitch that behaves as the Push to Talk button.

2.5 SUPERVISED ETHERNET TERMINATION BOARD UNIT

A. The Termination Unit shall be a Telecor Model eTBU-MI or approved equal. It shall reside on the facility's LAN providing provide two-way intercom communications between Consoles and industry standard 25 Volt speaker stations.

B. The Termination Unit shall distribute program audio to speaker locations and detect call-in annunciation from call switches in room locations. It shall be able to selectively transmit Paging, Audio Programs and Time Tone Signals originating on the eSeries Network Devices, to individual rooms, all rooms, selected rooms, or zones of loudspeakers.

C. The Termination Unit shall be consistent with the ANSI/NEMA SB 40 Standard for Communications Systems for Life Safety in Schools, supporting multiple call-in locations per room. These include the support of call-in devices with LED call assurance and privacy or do-not-disturb indication for each room. Multiple devices at a room location shall be configured to place call-ins with different destinations and priority levels. If the call-in destination of these devices is

a Console or an IP-PBX phone extension, the device display shall indicate the calling room location dial number, a textual room name, and the priority level of the call-in. Room locations can be configured with a primary, secondary, and back-up call-in destinations. Emergency priority call-ins placed from a room location shall be configured with a different call-in destination.

D. The Termination Unit shall support a Message Waiting (MW) feature. This feature shall use the LED on call stations to indicate waiting messages to room occupants. If no one is present in a room location to respond to a call or if the room is in Privacy or DND mode, the caller has the option to activate a MW indication. This causes the LED on the call station to pulse. When a call-in is initiated from the room, it shall be directed to the device that activated the MW indication and the MW indication will be deactivated.

E. The Termination Unit shall support the Privacy function on Call Stations that are equipped with a Privacy button. When pressed, the Privacy button shall place the room location in privacy mode. This shall prevent monitoring of audio in the room. In privacy mode, the LED on the Call Station shall illuminate to indicate privacy mode. When a call-in is placed from the room location, privacy mode shall automatically be suspended for the duration of the call and re-enabled afterwards. If a call is placed to the room location while in privacy mode, the caller shall be alerted to the privacy mode and given the option to connect the call, leave a message waiting indication, or to cancel the call.

F. The Termination Unit shall include support for the Do Not Disturb mode. Call Stations equipped with a Do Not Disturb (DND) button shall be able to place the room in DND mode when pressed. In DND mode, the LED on the Call Station shall flash to indicate that the station is in the DND mode. This shall suspend zone pages and normal priority audio distributions from being broadcast into that room. DND mode shall not prevent emergency priority operations from reaching the location. If a call is initiated from a room location that is in the DND state, the DND shall be automatically suspended for the duration of the call and re-enabled afterwards.

G. The Termination Unit shall also provide synchronization and correction of traditional Analog Clocks, as well as Electronic Message Displays. The digital signaling that provides support for these devices shall originate in the eSeries Network. Analog Clock correction formats supported by Legacy T2 or XL systems, shall also be supported by the Termination Unit.

H. The Termination Unit shall monitor the wiring of all room location call devices for call line failure. It shall analyze the wiring for an open circuit, short circuit, or short to ground conditions. In the event of a fault, the Termination Unit shall detect the fault and provide trouble notification messages to devices equipped with trouble LED and buzzers which will annunciate the trouble signals.

I. The Termination Unit shall be equipped with an integrated 25 watt, dual-purpose intercom/paging amplifier. It shall be used to provide amplification for two-way intercom communications to room stations, as well as amplification for paging, audio programs, and time tone signals to speaker locations. In the event that the audio load is greater than 25 watts, a line level output shall provide for the connection of an external power amplifier.

J. All speakers, when connected to the Termination Unit shall reside on an “Off Bus.” This shall ensure failsafe operation, where even in the event that network connectivity is lost, a redundant audio source can be connected to the “Off Bus” and emergency paging announcements can be transmitted to all speakers connected to the Termination Unit.

K. The Termination Unit shall mount in a standard rack panel measuring 19" W x 1.75" H and shall occupy a single rack unit. It shall be ideally suited for use with the Telecor C5PPL patch panel. Alternatively, two 50-pin, RJ-21 connectors shall provide termination facilities to a pair of TM-2X25 terminal blocks for connecting field devices. The unit shall be powered from an external 24 VDC Power Supply.

2.6 SUPERVISED SPEAKER BREAKOUT MODULE

A. The Speaker Breakout Module shall be a Telecor model eSBM-TB or approved equal. It shall provide the means of integrating traditional analog speakers and call initiating devices to the eSeries System. The Module shall also be a Single Zone Paging Adapter that can drive an amplifier to provide paging coverage in a facility. The Module shall have three relay outputs that can activate automatically during a call processing operation.

B. The Module shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power over Ethernet network switch, the Module shall be able to place or receive calls and pages from the eSeries network. The Module shall not require any network configuration or administration to function.

C. Speech shall be transmitted through the Module in crystal-clear HD Audio. Audio shall be transmitted in the frequency range from 50 Hz to 7 kHz and shall use a maximum of 128 kbps of bandwidth during a call. Audio between the Module and eConsoles shall be non-blocking.

D. The Module shall support eSTB-12 2x2 Ceiling Inlay Speakers, which shall connect to the eSBM-TB via a standard CAT5 cable or conventional 8Ω/25V/70V speakers to provide paging and talkback operation from eSeries e300 eConsoles or phones via an eSIP and an IP-PBX.

E. The volume of the speakers shall be adjustable individually, by zone, or across the entire eSeries network via the ePort Management Interface or eCI Control Interface. Volume controls incorporated into certain eCS station models shall also allow a user to adjust the speaker volume locally. Volume levels shall be set by specific functions: intercom, paging, emergency paging, and Public Channel operations.

F. Call-in capabilities shall be provided with addition of any of Telecor's eSeries Call Stations. The eCS-6 and eCS-3 shall be used to initiate Normal and Emergency calls respectively. Advanced stations that provide additional features shall also be available: the eCS-1 (Privacy and Normal Call), eCS-2 (Do Not Disturb and Normal Call) , and eCS-4 (Volume Control, Public Channel Select and Normal Call). All eCS Call Stations shall also provide "message waiting" indication.

G. The eSBM-TB shall also support placing normal and emergency priority call-ins from simple pushbutton call switches. Pressing the normal call switch shall initiate a normal call-in, and either pressing it three times quickly or pressing and holding it for three seconds to shall place an emergency call-in. Pressing the emergency switch once shall place an emergency call-in.

H. The Module shall have the ability to direct normal and emergency call-ins to different devices. If the device that is configured to receive the call-in loses network connectivity, the Module shall automatically search for an alternate destination. If no other suitable call-in destinations exist, the Module shall audibly and visually indicate a fault.

I. The Module shall have a call-in roll-over feature where if a call-in to the primary call destination is not answered after a preset amount of time, the call shall be automatically copied to a secondary call destination. If both the primary and secondary call destinations are unavailable, the call shall be redirected to a back-up eConsole.

J. The Module shall have the capability to be configured as a member of one or more paging zones.

K. The Module shall have a built-in 4-watt audio amplifier that shall drive up to 4 watts of audio to a small zone of 25/70 volt loudspeakers. The module shall provide a line level audio output that can connect to an external power amplifier for applications where the speaker zone load exceeds 4 watts.

L. The Module shall be monitored for network connectivity. If the Module's network connection is lost, targeted e300 eConsoles shall report that station as absent and display its dial number. When the Module is used with eCS Call Stations, the Module shall also provide full supervision and monitoring for Call Station and call-in destination connectivity. If a wiring fault is detected between an eCS Call Station and the Module, the Module shall audibly and visually indicate the error utilizing the status LEDs on the Module. The eCS Call Stations shall pulse to indicate a trouble condition. In case of a fault, the ePort or eLog shall log the location, time, date and type of fault. If so configured, the ePort, eLog, eCI and eAmplifiers shall also generate an alarm tone.

M. The Module's status LED that shall flash in different patterns to indicate normal operation, call-in assurance, message waiting, a call or paging audio in progress, or to indicate an error.

N. The Module shall be equipped with three relays that can be used to operate auxiliary devices such as strobe lights, tone initiating devices and door locks.

O. The eSBM-TB shall be wall-mounted using the attached mounting brackets.

2.7 SUPERVISED NETWORK AMPLIFIERS

A. The Supervised Network Amplifier (subsequently referred to as Network Amplifier) shall provide a minimum of 25 watts for paging and public address and shall be capable of utilizing analog amplifiers to increase the amount of amplified signal from the network amplifier. The Network Amplifier shall be connected directly to the network switch by an RJ45 connector and shall receive signals directly from the network.

B. The Network Amplifier shall be supervised and in the event that network communications is lost, an audible alert shall sound on the Amplifier. The Network Amplifier shall provide a silence feature to mute the audible alert for 24 hours.

C. The Network Amplifier shall also be capable of receiving local input from local devices such as tape decks, iPod docks, CD players, etc. The network amplifier shall be capable of transmitting signals received from the local input to other network locations or locally to directly connected 25/70 volt or 8 ohm analog speakers.

D. Each Network Amplifier shall be capable of providing two audio inputs for local devices and shall be programmable as either a microphone or line-level input.

E. The Network Amplifier shall be controlled remotely such that audio programs, input, tones, textual messages, or announcements may be initiated by other devices connected at different locations on the local area network.

F. The Network Amplifier shall have a minimum of 4 local tone/pre-recorded announcement audio message control lines which when activated will distribute tones/pre-recorded audio messages to intended network amplifiers for re-distribution, network talk-back speakers (or a zone), and/or local 25/70 volt or 8 ohm analog speakers directly connected to amplifier. Each network amplifier shall be capable of storing four (4) pre-recorded announcements in addition to a minimum of 16 tones. Tones and announcements shall be activated locally or from other network devices.

G. The Network Amplifier shall store and transmit companion textual messages for each stored audio announcements. Textual messages shall be automatically broadcasted to the same zones along with the audio messages such that any device programmed for that zone automatically receives both the audio and textual announcement/message and automatically reproduced each or both messages to the extent of the devices' capabilities.

H. The Network Amplifier shall be capable of transmitting HD level audio as defined by Intel(TM) High Definition Audio specifications, June 17th, 2010 at a minimum.

I. The Network Amplifier shall shut down to protect itself should an output short circuit fault or overload occur that jeopardizes the integrity of the Network Amplifier.

J. The Network Amplifier shall be able to continuously broadcast public channel audio that other devices shall be able to tune to. The Network Amplifer shall support one public channel audio source. The eSeries network shall support up to 10 simultaneous public channels. Public channel audio being received by any station device shall be of the lowest priority and will be overridden by any other audio broadcast, pages, and intercom calls.

2.8 SUPERVISED INTERACTIVE GRAPHICAL USER INTERFACE

A. The system shall include an Interactive Graphical User Interface (subsequently referred to as IGUI). The software shall reside on Telecor provided PC and should have ability to interface to District Wide Emergency Communication system located in district office.

B. The IGUI shall be supervised and shall utilize an easy-to-use Graphical User Interface for quick and easy graphically aided navigation to access functionality for all intercom stations, paging zones, and program distribution sources. Emergency operations shall be simplified through the IGUI allowing stored audio files and alphanumeric messages for message displays to be activated from the IGUI. The IGUI shall allow common operations such as daily announcements to become simplified into single touch activated icons; removing the need for multi-step console set ups and dial strings.

C. The voice device used to originate voice communication for the IGUI to selected locations shall be a system console, telephone handset, or microphone independent from the computer hosting the IGUI. The voice device shall remain functional and accessible regardless of the operational state of a computer supporting the IGUI.

D. The IGUI shall allow the creation of a custom operating screen(s) based on the floor plans of the facilities. Icons representing intercom stations, zones used for paging, tone distribution, textual Message distribution, and audio program distribution shall be incorporated onto the floor plans. The IGUI software shall provide:

1. Simple routine call processing, including: hold, transfer, and forward
2. Activation of remote station auxiliary relays for applications such as door lock or release
3. Emergency functions
4. Paging
5. Audio program distribution
6. Customizable page elements
7. Customizable operating screen
8. Element library for emergency event icons
9. Initiation of emergency and non-emergency messaging, textual and audible
10. Remote station volume adjustment
11. Remote activation of do not disturb status and/or message waiting status
12. Remote station trouble indication
13. Remote station background music channel selection
14. Dynamic zone management for interactive on-the-fly console specific zones
15. Single touch emergency response (supporting both actual emergencies and drills) including but not limited to all or any combination of the following:

    a. Live voice notification
    b. Pre-recorded audio message
    c. Digital plain text messaging with simultaneous numerically coded message capability
    d. Remote system activation, i.e., access control systems, CCTV systems, door release systems, etc.

E. The IGUI must provide an efficient and reliable method of notifying the occupants within the facility of critical situations. A variety of emergency tone signals that reside within the intercom/paging system shall be activated by clicking on pre-programmed buttons on the IGUI screen, initiating the transmission of tone signals to speakers, and alphanumeric messages to message displays. A “lockdown” icon shall be designed as per Owner direction, with Owner selecting the appropriate tone. Whole building macros for emergency or off-normal response shall be built into the internal communication system as directed by the Owner. Each macro shall be capable of being activated by the console, the IGUI as indicated on plans or as directed by the Owner or AHJ. It shall be possible to activate a WAV file message or Owner selected tone coinciding with multi-language textual messages for distributions to zones as directed by the Owner, all from a single activation icon located on the IGUI. Other single action macros shall be activated in similar fashion via the IGUI and a custom labeled icon. Plain language labeling of all icons on the IGUI shall be user changeable.

2.9 CONTROL INTERFACE

A. The Control Interface shall be a Telecor model eCI or approved equal. It shall provide a Desktop Application for PC interaction with the Intercom and Paging system, a Command Interface Protocol for external system interaction with 3rd party systems, Group Zone functionality, and a Scripting Engine supporting multiple sequential operations.

B. The system shall incorporate a Windows based Desktop application that makes use of a Command Protocol Interface, allowing external systems to interact with the Network Intercom and Paging System. Combined with the Scripting and Group Zones features, the Desktop application shall be able to generate a preprogrammed series of operations from a single action. These features shall be used in conjunction with a graphical user interface and the Microsoft Windows desktop.

C. Default Scripts shall be used to generate customized shortcuts according to the needs of a facility. These shortcuts shall then be placed directly on the Windows desktop and shall be able to activate virtually any Intercom and Paging function by clicking on the shortcut icon. These shall include activating:
   1. Alerts, audio distributions, coded and plain text messages, intercom operations.
   2. Pre-Recorded Evacuate, Lockdown, and All Clear audio files.
   3. Companion text messages for audio alerts.
   4. Coded messages on all secondary digital displays.

D. The Desktop Application shall also be able to use to activate SMS text messages, computer pop-up notifications, and email distributions in conjunction with any Desktop Script. Desktop Icons such as a Panic Button shall be able to send SMS notifications to a crisis team, advance warning to building occupants through pop-ups to heighten the level of awareness.

E. Any Desktop location running the Application shall have the ability to create and send an instant message using the Desktop's keyboard any display. The textual message can be sent independently or as a companion message to an audible alert.

F. The Desktop Application shall be capable of utilizing Soft Call and Panic buttons. Soft Call buttons shall be able to be created to operate as a call button on the desktop with a normal or emergency call priority. They shall also be able to be combined with other preset or on-the-fly custom text messages. Panic buttons shall allow a user to unobtrusively activate an audio path from the panic button location to another eSeries device at a security location. This shall allow security personnel to listen to an occurring situation and provide the appropriate response.

G. The System shall be capable of streaming multiple audio programs over 10 available channels, simultaneously, to speaker locations in the facility. The ability to turn the broadcast on or off to a specific location shall be controlled from the Desktop Application.

H. A user from the Desktop Application shall be able to enable or disable Do Not Disturb (DND) mode for a group of devices such as speakers or intercom stations.

I. Volume Adjustments to individual devices, devices in a zone, or all devices in the intercom and Paging System shall be able to be made from the Desktop Application

J. The Desktop Application shall be able to be used to create a call directory to provide the user with the ability to quickly and easily place calls to a large number of prospective recipients and locations. The shortcuts shall be able to be customized with the name of the call recipient or location. The call directory shall also be able to contain shortcuts that activate message waiting indications in addition to the option of placing calls.

K. The system shall interface with other external systems using a Command Interface Protocol. External systems include integrated security management or building management systems via devices such as computers, programmable logic controllers, or software based annunciator panels.

L. The Command Interface Protocol shall be used to send real time commands and receive real time status messages between the 3rd party system and eSeries devices. The Command Interface Protocol shall be an ASCII protocol that includes both outbound messaging, and support for inbound command via a virtual COM port and a physical USB connection.

M. Scripting shall allow operations to be carried out in sequence. Scripts shall be activated in various ways including: automatically based on the day of week and time of day, using an eConsole or a phone, or by using eDesktop, or from other scripts.

N. When scripts from an eConsole or PBX phone (via eSIP), the name of the script shall be displayed on the eConsole or phone. Then the user shall be presented with options to enable or disable the script (depending on the current state of the script). eConsoles and PBX phones that dial the script number shall hear voice prompts for enabling or disabling the script.

O. Scripts shall be used for scheduling time tone programs that include tones, pre-recorded messages, and textual messages displayed on e365-TB Message Display reoccurring at specific times and days.

P. Scripts shall be able to perform cascading evacuation operations where evacuation audio messages are automatically first distributed to zones closest to the location of an emergency before spreading outwards to other zones according to a time schedule, thus reducing evacuation route congestion throughout the facility.

Q. Group Zones shall allow groups of page zones or devices to be defined as a group zone with a dial number. Group Zones shall be able to be accessed from eDesktop, eConsoles or PBX phones.

R. Group zones shall be the destination for various functions including textual messages, or audio operations, such as pages or audio program distributions). Group zones shall be assigned customized names which will appear on eConsole or phone displays when they are dialed.

S. Group Zones shall make it possible for a dial number to forwarded to a different destinations based on time and day. For example, common audio operations directed to a Group Zone dial number shall be able to be configured to go to the usual destination during regular hours but to a different destination outside of regular hours.

T. Group Zone shall support designated priorities, such as emergency. Operations that are to a zone with a priority are automatically elevated to override any normal or lower priority operations the devices in that group zone are receiving.

2.10 SUPERVISED SIP TRUNK IP/PBX INTERFACE

A. The system Session Internet Protocol (SIP) Interface shall be a VoIP PBX phone interface of the same manufacturer as the supervised network intercom and paging system. Third party gateway devices shall not be accepted.

B. The SIP Interface shall be supervised and shall connected directly to the facility's network and the PBX’s network and shall provide the following:
   1. Establish a barrier gateway between the intercom and paging network and the PBX and/or common computer network.

2. Transparent audio operation between VoIP PBX phones and any device on the supervised network intercom and paging system. Paging access from any telephone on the facility system VoIP PBX to any intercom speaker, speaker zone, intercom station, console, all speakers, or paging horns and zones throughout the facility.
3. Any call-in from the supervised network intercom and paging system shall be capable of being routed directly to a VoIP PBX phone. Call-in stations can be configured and programmed to automatically dial any number on the publicly switched telephone network, landline, or cellular number through the SIP interface and via the PBX.
4. Ability to escalate a call-in directed to a console to be redirected to a VoIP PBX connected phone via the SIP Interface. Escalation can also include the ability to dial any number on the publicly switched telephone network, landline, or cellular number through the SIP interface via the PBX.
5. Ability to initiate alarm and crisis response protocols from any VoIP PBX connected phone.
6. Ability to require security access code to utilize the intercom or paging system emergency communication features.
7. Minimum of 10 simultaneous telephone channels of access to/from VoIP PBX phone system. Full caller ID support from any supervised network intercom call-in device to a VoIP PBX connected phone identifying the calling station ID/Location.
8. Emergency level call-in to be uniquely identified as emergency on the VoIP PBX phones.
9. Activation of all supervised networked intercom and paging system emergency tones and pre-recorded announcements from any phone connected to the building VoIP PBX phone system.
10. The SIP Interface shall additionally allow for calls to be placed from a console to any phone number on the publicly switched telephone network (landline or cellular). Additionally, intercom calls at a console may be transferred to any number on the publicly switched telephone network to any landline or cellular number through the SIP interface via the PBX.

C. Systems that connect to a building or district phone system and are limited to a SLT or CO connection will not be accepted as a substitute for a fully operational SIP Interface.

D. The SIP Interface shall support integration with InformaCast systems. The InformaCast system shall be able to activate messages activated via dialing on a Console and via the InformaCast web interface. The InformaCast messages shall include text to message displays, pre-recorded audio, and ad-hoc audio to eSeries devices which will be appropriately distributed to targeted and applicable eSeries devices.

PART 3 - EXECUTION

3.1 Install the system in accordance with the manufactures printed instructions and recommended cable types.

3.2 Provide point to point wiring diagrams showing location of all wire pulls. Mark all cables corresponding to point to point wiring diagrams.

3.3 System Acceptance Test

A. Have the company field adviser adjust the completed system to desired volume levels of customer.
B. The system shall operate for at least two weeks with no failures or changes required.

C. Test every circuit in the system to ensure proper operation.

D. Test each daily function school will be using making sure staff is knowledgeable in the operation of the system.

E. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal hours. The warranty period shall begin on the date of acceptance by the Owner.

F. The Contractor shall, at the Owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

G. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

END OF SECTION 275134

SECTION 275313 – WIRELESS CLOCK SYSTEM

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS & SCOPE

A. Furnish and install a complete new wireless clock system using Telecor Inc. wireless system.

B. All bids shall be based on the equipment as specified herein. The catalog numbers and model designations are that of Telecor Inc. The specifying authority must approve any alternate system.

C. Bidders wishing to submit alternate equipment shall submit to the specifying authority, at least ten (10) days prior to bid opening, the equipment proposed to provide a precise functional equivalent system to meet specifications. Bidder shall provide adequate information prior to bid date such as specification sheets, working drawings, shop drawings, and a demonstration of the system. Alternate supplier-contractor must also provide a list to include six (6) installations of the identical system proposed which have been in operation for a period of two (2) years.

D. Final approval of the alternate system shall be determined at the time of job completion. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate system at the contractor's expense.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to this Section.

B. Requirements of the following apply to this Section:

1. Basic Electrical Requirements
2. Basic Electrical Materials and Methods

1.3 SUMMARY

A. This Section addresses the needs and requirements of the wireless clock system. It includes requirements for the wireless clock system components including, but not limited to, the following:

1. Wireless Transceiver
2. Wireless Repeater
3. Secondary Analog Clock

1.4 SYSTEM DESCRIPTION

A. General: Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating wireless clock system.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract

B. Sections:

1. Submit equipment prints, full electronic wiring diagrams and specifications sheets for each item specified herein. Provide a tabulation of the specification clearly comparing the submitted item with the specified item, being able to refer to all written expressed functions and capabilities. Specification sheets shall be submitted on all items.
   a. Shop drawings detailing wireless clock
2. Wiring diagrams, detailing wiring for power, signal, and control.
3. Submit wiring diagrams showing typical connections for all equipment.
4. Submit a certificate of completion of installation and service training.

1.6 QUALITY ASSURANCE

A. All items of equipment shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

B. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least three (3) years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full manufacturer's warranty privileges.

C. The contractor shall show satisfactory evidence, upon request, that the supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The supplier shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to:
1. Article 250, Grounding.
2. Article 300, Part A. Wiring Method.
3. Article 310, Conductors for General Wiring.
4. Article 725, Remote Control, Signaling Circuits.
5. Article 800, Communication Systems.

E. Installation and start up of all systems shall be under the direct supervision of a local agency regularly engaged in installation, repair, and maintenance of such systems. The supplier shall be accredited by the proposed equipment manufacturers.

F. The agency providing equipment shall be responsible for providing all specified equipment and mentioned services for all equipment as specified herein. The agency must be a local authorized distributor of all specified equipment for single source of responsibility and shall provide documents proving such. The agency must provide written proof that the agency is adequately staffed with factory-trained technicians for all of the specified equipment. The agency must have established business for and currently be providing all services for the equipment.

G. The contractor shall guarantee availability of local service by factory-trained personnel of all specified equipment from an authorized distributor of all equipment specified under this section. Maintenance shall be provided at no cost to the purchaser for a period of one (1) year (parts and labor) from date of acceptance unless damage or failure is caused by misuse, abuse, neglect, or accident. Additionally, all manufacturer supplied products must be covered by three (3) year (parts only) limited warranty from the date of acceptance. The warranty period shall begin on the date of purchase by the owner/engineer.

H. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

I. The supplier shall visit the sites and familiarize himself with the existing conditions and field requirements prior to submitting a proposal.

J. The contractor is responsible for all cost associated with proper installation, termination, configuration, programming, impedance and load matching of all system components.

K. The contractor shall provide all necessary masonry, covering, patching, and painting work in order to render any residue of the existing central equipment invisible. All finished surfaces shall be chosen in consultation with the Owner, to assure that the Owner's aesthetic preferences have been adhered to.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory boxes. Store in clean, dry space in original boxes. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.8 IN-SERVICE TRAINING

A. The contractor shall provide training with this system. These sessions shall be broken into segments that will facilitate the training of individuals in the operation of this system. Operators Manuals and Users Guides shall be provided at the time of this training.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. The manufacturer shall be:
Telecor Inc. 6205 Kestrel Road, Mississauga, Ontario, L5T 2A1
www.telecor.com

B. The new wireless clock systems shall each be a Telecor Wireless Clock System.

C. The intent of this specification is to establish a standard of quality, function and features. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications.

D. The functions and features specified are vital to the operation of this facility, therefore, the acceptance of alternate manufacturers does not release the contractor from strict compliance with the requirements of this specification.

E. The Contractor for this work shall be held to have read all of the Bidding Requirements, the General Requirements, and Contract Proposal Forms; and in the execution of this work, he will be bound by all of the conditions and requirements therein.

F. The contractor shall be responsible for providing a complete functional system including all necessary components whether included in this specification or not.

G. In preparing the bid, the bidder should consider the following:
   1. No claim will be made against the owner for any costs incurred by the bidder for any equipment demonstrations which the owner requests.

H. Any prior approval of an alternate system does not automatically exempt the supplier from the intent of these specifications. Failure to comply with the operational and functional intent of these specifications may result in the total removal of the alternate system at the expense of the contractor.

I. Alternate equipment shall be considered if submitted to the specifying authority at least ten (10) days prior to bid date. Submission of an alternate shall contain an original draft point by point comparison of the submitted product relative to the requirements of this specification, engineering drawings of the system, and specification sheets covering all components of the system as well as all items of Section 1 “SUBMITTALS”. The system and equipment drawings and specification sheet shall meet all items of the specification.

J. Proposed alternate equipment shall be accompanied by a letter from the manufacturer clearly stating that they have read the specifications, have listed differences between their product and the specified product, and commit to meet or exceed the specified requirements herein.

K. All proposed alternate systems must comply with Section 2.1, letters H and I above. Submissions failing to comply with the aforementioned requirement shall be deemed as non-compliant.

2.2 SYSTEM REQUIREMENTS

A. Wireless analog clock system with interface capability to eSeries Intercom and Paging System.

2.3 SYSTEM

A. The system can operate as a stand alone system or in conjunction with an eSeries Intercom and Paging System. The system shall have interface capability to GPS, network, Internet and existing clocks systems such as 58 minute, 59 minute, sync-wire secondary analog clocks.

B. The system shall be designed to work in an environment where cabling options are not available. The system shall be capable of working in 915-928 MHz frequency-hopping technology. The system shall be capable of automatic transmission of data along 51 alternating frequencies that allows for an enhanced signal, even if there is interference in one of the frequencies.

C. Each clock in the system shall be capable of receiving and transmitting the wireless signal which allows it to be used as a repeater while boosting the data stream and sending along the system. With this dual capability there shall be no limit on the number of clocks that can be used in the installation. The clock shall be designed to automatically work together without interference with each other. The system shall be capable of increasing the quality of the signal while increasing the quantity of the clocks.

D. The analog clocks shall be capable of working in one (1) of the following options
   1. Two (2) D cell batteries; the clock receives and transmits time every four (4) hours.
   2. 110 volts AC; the clock receives and transmits time every one (1) minute.
   3. 24 volts AC/DC; the clock receives and transmits time every one (1) minute.

E. The analog clock shall include automatic digital calibration for time base to minimize deviation from each other.

F. The analog clock shall have a built-in close-loop system that will allow the clock to detect the position of the hands and bring the clock to the right time even if the clock were manually or forcefully altered.

G. The analog clock shall have the capability for diagnostic function that will allow the user to view the quality of the signal, how long since the last time the clock received a signal, as well as functional tests of the electronics and the gears.

H. The system shall operate in a license-free frequency range where no license is required.

2.4 FCC APPROVAL

A. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
   1. Reorient or relocate the receiving antenna.
   2. Increase the separation between the equipment and receiver.
   3. Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
   4. Consult the dealer or an experienced radio/TV technician.

2.5 PRODUCT

A. Transmitter/Transceiver

   1. The Master Clock / Transmitter shall be the Telecor Model 2490 Transceiver. The transmitter shall be capable of transmitting data to the Telecor wireless analog clock clock. The transmitter shall be capable of receiving a signal from an atomic clock web site via the Internet. The transmitter will be capable of receiving correction from all Telecor Master Clocks, as well as 59 minute correction, 58 minute correction, National Time and Rauland, and Dukane. The transmitter shall have a programmable auxiliary

relay and shall be programmed anywhere from 1—99 seconds. Upon utilization of the relay, the transmitter will be capable of interfacing with a once a day closure or interfacing with intercom systems. The transmitter shall be capable of acting as a repeater while receiving a signal wired or wirelessly from the main transmitter. The time base shall be temperature controlled allowing calibration of the time base during temperature changes. The transmitter will have two (2) switches for operation of the menu system. The transmitter shall utilize 915–928 MHz frequency–hopping technology. The transmitter shall be FCC compliant, part 15 Section 15,247.

B. Repeater

1. The repeater shall be a Telecor Wireless Repeater. The repeater shall wirelessly transmit and receive data. The repeater shall be capable of transmitting to the Telecor wireless analog clock. The repeater shall work on 915–928 MHz frequency–hopping technology. The repeater shall wirelessly transmit and receive data. The repeater is to have a maximum antenna size of seven (7) inches. The repeater shall have an RF input sensitivity of –103 dbm. The repeater is to have a RF power output of 27 dbm. The voltage input for the repeater shall be 110 volts/60 Hz or 220 volts/50 Hz. The repeater shall have three (3) knockouts with a diameter of 7⁄8”. The case shall be a compact, smooth surface metal enclosure. The repeater is to weigh 3.5 pounds. The repeater shall be FCC Compliant, part 15 Section 15,247.

C. Analog Clock

1. The secondary clock shall be Telecor 2490 Series wireless clock. The clock will be capable of receiving a signal from multiple clocks. The clock shall receive and transmit with 915–928 MHz frequency–hopping technology. The clock is to be capable of transmitting the time simultaneously without interfering with each other. The clocks shall include automatic calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, a gearbox test and a comprehensive analysis of the entire clock. The clock shall have a maximum correction time of five (5) minutes. It shall be designed to be used with the Telecor Transceiver or the Telecor Repeater, which can be regulated via Telecor wireless communication protocol. Upon receipt of the wireless signal, the clock will immediately self–correct. The clock shall have a semi–flush smooth surface ABS case. The dial is to be made of durable polystyrene material. The crystal is to be shatterproof, side molded polycarbonate. Glass and visible molding marks are unacceptable. The clock shall have black hour and minute hands as well as a red second hand. The clock shall be FCC compliant, part 15 Section 15,247.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the wireless clock system.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install system in accordance with applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. Wiring Methods:

   1. Conceal wiring except in unfinished spaces.
   2. All new wiring on this project must be properly rated for the application.
   3. Cable to the new devices at new locations shall be installed in a neat and workmanlike manner, following the standard procedures used in the electrical contracting trade.
   4. Exposed wiring will not be permitted under any circumstances on this project.
   5. Any wiring, which is considered sloppy by the Engineer, shall be strictly unacceptable.
   6. Upon installation completion, a room-by-room test shall be conducted for every device in the system. A technician shall perform the test after school hours, and repairs shall be performed as needed at no cost to the Owner to any devices, which do not function correctly, including cable. A written room-by-room report following testing and repairs shall be prepared and submitted to the Engineer.

3.3 FIELD QUALITY CONTROL

A. Contractor Field Service:
   1. Provide services of a service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection
   1. Make observations to verify that units and controls are properly labeled.

C. Testing:
   1. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at the Contractor's expense. Verify by the system test that the total system meets the specifications and complies with applicable standards.

3.4 COMMISSIONING

A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Operators Manuals and Users Guides shall be provided at the time of this training.

B. Schedule training with Owner through the Architect, with at least seven (7) days advance notice.

3.5 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 275313

SECTION 281300 - ACCESS CONTROL SYSTEM HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Access Control Server Appliance.

B. Related Sections:
   1. Section 28 01 00 - Operation and Maintenance of Electronic Safety and Security.
   2. Section 28 05 45 – Systems Integration and Unified Systems.
   3. Section 28 49 00 - Electronic Personal Protection Systems.
   4. Section 28 23 13 - Video Management System Interfaces.
   5. Section 28 49 00 - Electronic Personal Protection Systems.
   6. Section 28 51 15.11 - Information Interfaces to Access Control Systems.
   7. Section 28 51 15.13 - Information Interfaces to Video Surveillance Systems.
   8. Section 28 51 15.15 - Information Interfaces to Security Detection, Alarm, and Monitoring.
   9. Section 28 51 15.17 - Information Interfaces to Security Monitoring and Control.
   10. Section 28 51 15.19 - Information Interfaces to Mass Notification Systems.
   11. Section 28 51 15.21 - Information Interfaces to Life Safety Systems.
   12. Section 28 51 17 - Data Presentation.
   13. Section 28 51 19 - Control Room and Monitoring Equipment.

1.2 ADMINISTRATVE REQUIREMENTS

A. Coordination:
   1. Coordinate with Owner or Owner’s representative regarding network configuration and estimated throughout utilization prior to performing network connections.

B. Sequencing / Scheduling: Provide to Owner or Owner’s representative a schedule and list of participants required to attend coordination and progress update meetings.
   1. Owner representative(s) for Facilities Management, Information Technology (IT) Services, and Security Management.
   2. General Contractor.
   3. Project Manager.
   4. Manufacturer’s Representative.
   5. Project Architect.
   6. Project Engineer.
   7. Security Consultant.

1.3 INFORMATIONAL SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
   1. Substrate preparation instructions and recommendations
   2. Installation means and methods.
   3. Recommendations and requirements for proper storage and handling.

C. Shop Drawings:
   1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
   2. Coordinate with locations listed on Contract Drawings.

D. Warranty Information:
   1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.

E. System Support Resources:
   1. Submit a list of available manufacturers providing fee based professional services available to the Contractor or Owner, including but not limited to the following:
      a. Training.
      b. Installation.
      c. Commissioning.
      d. Remote diagnostics and integration with 3rd party software and hardware systems.

1.4 CLOSEOUT SUBMITTALS

A. Supply licensing and registration information for all software, hardware, firmware, operational, and administrative licenses.

B. Supply network configuration backup files, restoration application and instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide products from manufacturer(s) with a minimum of 5 years in manufacturing access control and building automation products specified in this section.

B. Installer Qualifications:
   1. Installer must be licensed to install video surveillance and security equipment as required by authority having jurisdiction.
   2. Installer must be certified in good standing by the manufacturer prior to bid date.
   3. Installer must be capable of providing references that will attest to successful completion of projects of similar scope as the work noted in this section.

1.6 WARRANTY

A. Manufacturer Warranty: Provide manufacturer's warranty covering parts and labor costs to repair or replace part that fail to perform.
   1. Warranty Period: Parts and labor warranty for 36 months from date of Substantial Completion or date of purchase, whichever comes first.
   2. Service During Warranty: Provide direct support to Owner via phone and email, including access to training and education in the form of documents, videos and other materials via the internet.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: Motorola Solutions by The Tri-M Group, LLC.
   1. Contact Info: Jeremy Adams- JAdams@Tri-MGroup.com (610) 656-2701.

B. Manufacturer List:
   1. Manufacturer: Motorola Solutions: Access Control Manager by The Tri-M Group, LLC.

C. Substitution Limitations:
   1. No Substitutions Permitted.

2.2 ACCESS CONTROL SERVER APPLIANCE

A. General: Provide access control server appliance as part of an expandable, role-based physical access control system with the following functionality:
   1. Software: Provide access control system software in accordance with section 28 13 00.
   2. Integrations: Provide system compatible with third party open field hardware.
   3. Interface: Provides access from web browser to allow full access to alarms, events, hardware and history from multiple devices, including mobile devices.
   4. Coordination: Integrates with a network video management system to coordinate video alarm events and physical access system.
   5. Administration: Provides remote access and administrator control, failsafe performance through cloud-based server architecture, and best practices backup, update, and upgrade performance.

2.3 ACCESS CONTROL SERVER ENTERPRISE APPLIANCE

A. Basis of Design Product: Access Control Manager - Enterprise, by Motorola Solutions Installed by The Tri-M Group, LLC.
   1. Model: AC-APP-16R-ENT2-6; Access Control Enterprise Appliance with 16 readers.
   2. Add-on: AC-SW-LIC-16RCU-6-P; Access Control Manager 6, 16 Reader Count Software License. (Up to the supported maximum of 400 reader licenses.)

B. System:
   1. Operating System: Secure embedded Linux OS.
   2. Storage: 1 TB SATA Hard Drive.
   3. Processor: Intel Xeon.
   4. Memory: No less than 8 GB DDR4 RAM.
   5. Network Interface: No less than Two Gigabit Ethernet RJ-45 port (1000Base-T).
   6. Integrated Remote Access Controller: Dell iDRAC 9 Enterprise.

C. Mechanical:
   1. Form Factor: Standard 1U Rack mount chassis.
   2. Dimensions: 42.8 mm x 482.4 mm x 676.9 mm; (1.68” x 18.99” x 26.65”).
   3. Weight: 8.77 kg (19.32 lbs).

D. Power:
   1. Input: 90 to 264 VAC, 47-63 Hz.
   2. Power Supply: Single non-redundant.
   3. Power Consumption: 250 W.

E. System Capacities:

1. Card Readers: 16 to 400.
2. Inputs: 5060.
3. Outputs: 5060.
4. Maximum Controller Count: 1024.
5. Maximum Simultaneous Operators: 20.
6. Maximum Identity Count: 250,000.
7. Transactions (60 Minutes Sustained): 50,000.
8. Maximum Stored Events: 150,000,000.

F. Operating Range:
1. Temperature: 10° C to 35° C (50° F to 95° F).
2. Humidity: 10 - 80% Relative humidity (non-condensing).
3. Vibration: 0.26Grms at 5–350Hz for 15 minutes.
4. Shock: Six (6) pulses of 6 G for up to 11ms.
5. Altitude: -15.2 m (-50 ft) to 3048 m (10,000 ft).

PART 3 EXECUTION

3.1 PREPARATION

A. Configure and test access control system according to manufacturer's instructions.

B. Test system configuration(s) in accordance with instructions provided by manufacturer.

3.2 INSTALLATION

A. Install access control server appliance according to manufacturer's written instructions.

B. Develop, install, and test software and databases for complete and proper operation of systems involved.

C. Initialize system such that no additional programming is required, including setup of available software features.

D. Review configurable features with Owner's Representative and establish a punch list for standard, device specific, location specific and access control specific configurations.

E. Configure equipment requiring users to log on using a password with user/site-specific password/passwords. Retaining default passwords is not allowed.

3.3 CLOSEOUT ACTIVITIES

A. Demonstration:
1. Demonstrate administration and operation of devices described in this section.
2. Demonstrate how to authorize users and applications to operate and configure installed devices.
3. Demonstrate how an authorized user can gain access to and make changes to configuration.
4. Demonstrate how to operate functionality configured for this project as defined by configuration punch list.

B. License Assignment:

1. Register software, hardware, firmware, operational or administrative licenses necessary for to operate or administer devices to Owner.
2. Deliver to Owner's Representative proof of license registration from product manufacturer.

C. System Adjustments:
1. Program and configure devices in accordance with the established punch list such that no additional programming is required for operation by user.
2. Modify configurations as necessary to adjust operating parameters and sequence of operations based on the Owner's operating requirements.

D. Device Configuration Backup:
1. Using access control system server backup functionality, perform a full system backup at the completion of the initial programming to a USB drive or customer local network shared folder (preferred option). Backup function could also be scheduled to execute system backup periodically.
2. Deliver configuration backup files, restoration application and instructions detailing for restoration of back-up configuration.

END OF SECTION 281300

SECTION 281400 ACCESS CONTROL SYSTEM SOFTWARE AND DATABASE MANAGEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Access Control Software.
2. Access Control Software Collaborations.
3. Access Control Hardware Software Integrations.
4. Access Control Software Interface.
5. Access Control Software Administration.
6. Accessory Software Schedule.

B. Related Sections:
1. Section 08 71 00 - Door Hardware
2. Section 28 01 00 - Operation and Maintenance of Electronic Safety and Security.
3. Section 28 05 45 – Systems Integration and Unified Systems.
4. Section 28 49 00 - Electronic Personal Protection Systems.
5. Section 28 23 13 - Video Management System Interfaces.
6. Section 28 49 00 - Electronic Personal Protection Systems.
7. Section 28 51 15.11 - Information Interfaces to Access Control Systems.
8. Section 28 51 15.13 - Information Interfaces to Video Surveillance Systems.
9. Section 28 51 15.15 - Information Interfaces to Security Detection, Alarm, and Monitoring.
10. Section 28 51 15.17 - Information Interfaces to Security Monitoring and Control.
11. Section 28 51 15.19 - Information Interfaces to Mass Notification Systems.
12. Section 28 51 15.21 - Information Interfaces to Life Safety Systems.
13. Section 28 51 17 - Data Presentation.
14. Section 28 51 19 - Control Room and Monitoring Equipment.

C. Definitions:
1. Anti Passback (APB): A security measure that aims to prevent consecutive entries for one access card or prevent multiple people from using the same access card.
2. Open Supervised Device Protocol (OSDP): An access control communications standard.
3. Secure Copy Protocol (SCP): A means of securely transferring computer files between a local host and a remote host or between two remote hosts.
4. Software Development Kit (SDK): A collection of software development tools in one installable package.
5. Video Management System (VMS): A component of a security camera system that collects video from cameras and other sources, records and stores that video to a storage device, and provides an interface to both view the live video, and access recorded video.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate with Owner or Owner’s representative regarding network configuration and estimated bandwidth utilization prior to performing network connections.

B. Sequencing / Scheduling: Provide to Owner or Owner’s representative a schedule and list of participants required to attend coordination and progress update meetings.
1. Owner representative(s) for Facilities Management, Information Technology (IT) Services, and Security Management.

2. General Contractor.
3. Project Manager.
4. Manufacturer's Representative.
5. Project Architect.
6. Project Engineer.
7. Security Consultant.

1.3 INFORMATIONAL SUBMITTALS

A. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
   1. Substrate preparation instructions and recommendations
   2. Installation means and methods.
   3. Recommendations and requirements for proper storage and handling.

B. Shop Drawings:
   1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
   2. Coordinate with locations listed on Contract Drawings.

C. Warranty Information:
   1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.

D. System Support Resources:
   1. Submit a list of available manufacturers providing fee based professional services available to the Contractor or Owner, including but not limited to the following:
      a. Training.
      b. Installation.
      c. Commissioning.
      d. Remote diagnostics and integration with 3rd party software and hardware systems.

1.4 CLOSEOUT SUBMITTALS

A. Supply licensing and registration information for all software, hardware, firmware, operational, and administrative licenses.

B. Supply network configuration backup files, restoration application and instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide products from manufacturer(s) with a minimum of 5 years in manufacturing access control and building automation products specified in this section.

B. Supplier Certifications: Provide products from a supplier in compliance with the following:
   1. Department of Homeland Security Safety Act Certified.
   2. NISPOM Compliance (National Industrial Security Program Operating Manual).
   3. HSPD-12 and FIPS201-2 Certified.
   4. GSA Approved product list.

C. Installer Qualifications:
   1. Installer must be licensed to install access control and security equipment as required by authority having jurisdiction.
   2. Installer must have certified staff on access control products prior to bid date.
   3. Installer must be in good standing by the manufacturer prior to bid date.

4. Installer must be capable of providing references that will attest to successful completion of projects of similar scope as the work noted in this section.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: Motorola Solutions By The Tri-M Group, LLC.
   1. Contact: Jeremy Adams- JAdams@Tri-MGroup.com (610) 656-2701.

A. Manufacturer List:
   1. Motorola Solutions: Access Control Manager By The Tri-M Group, LLC.

B. Substitution Limitations:
   1. No Substitutions Permitted.

2.2 ACCESS CONTROL SOFTWARE

A. Basis of Design: Access Control Manager, by Motorola Solutions Installed by The Tri-M Group, LLC.

B. Operating System: Secure embedded Linux OS.

C. Access Control Software Capacities:
   1. Intelligent Controllers: 1024 per appliance allowing geographic independence from appliance via IP communication.
   2. Access Control System Appliances Supported: Up to 100 linked appliances using replication.
   3. Events Stored: Up to 150,000,000 per appliance.
   4. Events Stored: Up to 75,000,000.
   5. Sub-Panels: Up to 32 per intelligent controller.
   6. Doors: Up to 64 per intelligent controller.
   7. PIN Length: Between 2 and 8 digits.
   8. Card Formats: Up to 128 per appliance.
   9. Time Schedules: 255 per intelligent controller.
   10. Holidays: 255 per intelligent controller.
   11. Identity and Operator Database: Up to 500,000.
   12. Client Connections: Up to 50.

2.3 ACCESS CONTROL SOFTWARE COLLABORATIONS

A. Database Collaborations and Integrations: Provide access control software capable of integration with the following industry standard third-party databases.
   1. Bidirectional:
      a. Lightweight Directory Access Protocol (LDAP/Active Directory).
      b. Structured Query Language (SQL) Server.
      c. Oracle Relational Database Management System (RDBMS).
      d. Comma Separated Value (CSV).
      e. REST API Integration.
   2. Push Only:
      a. Extensible Markup Language (XML) for Event Push.

B. Visitor Management Integration:
      a. HID Global: Easy Lobby.
      b. Splan.

c. Envoy
d. Savance.

C. Custom Integrations
1. Destination Dispatch
2. Custom Integrations using RestAPI (as needed for project requirements)

D. Video Integrations: Coordinate integration and unification requirements with 28 05 45.
1. Avigilon Control Center.

2.4 ACCESS CONTROL HARDWARE INTEGRATIONS

A. Panel Hardware:
1. Mercury Security: Series 1, Series 2, and Series 3.

B. Supported Reader Hardware:
1. Readers capable of OSDP and Wiegand data format.
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 Virdi 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 FailoverAC-SW-LIC-AF-6-P; hot standby auto failover software license, one per appliance.
3. Partitioning: AC-SW-LIC-PART-6-P; for additional partitions, one per appliance.

G. IT Collaboration Software Licenses:
1. Microsoft SQL: AC-SW-LIC-SQL-6-P; from Microsoft SQL Server 2000 forward, one per appliance.
2. Oracle: AC-SW-LIC-ORCL-6-P; from Oracle DB 9i Server forward, one per appliance.
3. LDAP Directory: AC-SW-LIC-LDAP-6-P; for Microsoft Active Directory or other, one per appliance.
4. XML: AC-SW-LIC-XML-6-P; for XML events, one per appliance.
5. REST: AC-SW-LIC-REST-6-P; perpetual, for unlocking REST-based API for custom integrations, one per appliance.

2.10 ACCESSORY HARDWARE SCHEDULE

A. Panels:
1. Mercury: Controllers; Series 3 (LP1501, LP1502, LP2500, and LP4502).
2. Mercury: Controllers; Series 2 (EP1501, EP1502, and EP2500).
3. Mercury: Controllers; Legacy (SCP, SCP-C, and SCP-E.
4. Mercury: Sub Panels; MR50, MR52, MR16IN, MR16OUT, MR51E, and MR62E).
5. Mercury: Conversion Boards; M5 Bridge.
6. Mercury: Conversion Boards; MS Bridge.
7. HID: Controllers; V2000 and V1000.
8. HID: Sub Panels; V100, V200, and V300.
9. Salto: Controllers; CU42E0XXX and CU4200XXX via SALTO SHIP integration to Pro Access Space.

B. Enclosures:
1. Life Safety Power: Mercury Security.
2. Unified Power: Mercury Security; 2/4/8/16/24 Door Enclosures with or without network module.
3. Unified Power: Mercury Security; ProWire Pre-Wired Power.
4. Unified Power: Mercury Security; Tie Wrapped 4/8/16 Door Enclosures.
5. Unified Power: Mercury Security; Panduit 8/16/24 Door Enclosures with or without Network Module
6. Unified Power: Salto; 4/6/8/10 Door Enclosures with or without network module.

C. Readers:
1. HID: Prox.
2. HID: R Series.
3. HID: Signo.
4. Allegion: Schlage Series.
5. Farpointe: Pyramid.
6. Farpointe: Delta.

7. Farpointe: Conekt.
8. Salto: XS4 Readers via SALTO SHIP integration to Pro Access Space.

D. Wireless Locks and Peripherals:
1. Allegion/Schlage: AD300.
2. Allegion; Schlage: AD400.
3. Allegion; Schlage: NDE[B].
4. Allegion; Schlage: LE[B]MS.
5. Allegion; Schlage: LE[B]MB.
6. Allegion; Schlage: Control Smart Deadbolt (BE467F, FE410F).
7. ASSA ABLOY: Aperio Line of Devices
8. ASSA ABLOY Wi-Fi & POE via integration to DSR
9. Salto: Salto Systems: Locks via SALTO SHIP integration to Pro Access Space.
10. SimonsVoss: SmartIntego Series.
11. Schlage: LEB via RS-485.
12. Schlage: NDEB via RS-485.

E. Crash Bars:
1. Von Duprin: RU & RM Crashbar retrofit kits.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to installation, ensure Access Control Hardware Appliance is capable of required Access Control Software Features and Integrations.

3.2 INSTALLATION

A. Install system according to manufacturer's written instructions.
1. Develop, install, and test software and databases for complete and proper operation of systems involved. Activate and install all software and accessory software licenses.
2. Setup and program entire system so that no additional programming is required after Substantial Completion, including setup of available software features.
3. Perform a full system back-up at completion of initial programming and deliver configuration and transaction backups to Owner.
4. Perform field software changes after the initial programming session to "fine tune" operating parameters and sequence of operations based on revisions to the Owner's operating requirements including the creation of time schedules, holidays, new card formats, etc. Create user hierarchy with access permissions. Set up notifications.
5. Test equipment and configure system in accordance with instructions provided by manufacturer prior to installation.

B. Ensure products are equipped with latest and most up-to-date firmware and/or software by manufacturer.

C. Review configurable features of device with Owner's Representative and establish a punch list for standard, device specific, location specific and access control software-specific configuration of device(s).

D. Program and configure devices in accordance with this punch list so no additional programming is required for operation by user.

E. Configure equipment requiring users to log on using a password with user/site-specific password/passwords.

F. No system/product default passwords allowed.

3.3 CLOSEOUT ACTIVITIES

A. Demonstration:
   1. Demonstrate administration and operation of access control system.
   2. Demonstrate how an authorized user can log in and make changes to configuration of card holders, door access, and run reports.
   3. Demonstrate how to operate functionality configured for this project as defined by configuration punch list.

B. Fine Tuning:
   1. Perform field software changes after initial programming session to “fine tune” operating parameters and sequence of operations based on any revisions to Owner’s operating requirements.

C. License Assignment:
   1. Register software, hardware, firmware, operational or administrative licenses necessary for to operate or administer devices to Owner including the end user license agreement (EULA).
   2. Deliver to Owner’s Representative proof of license registration from product manufacturer.

D. Device Configuration Backup:
   1. Using access control system backup functionality, perform a full system backup at the completion of the initial programming to a USB drive or customer local network shared folder (preferred option). Schedule backup function to execute system backup periodically.
   2. Deliver configuration backup files, restoration application and instructions detailing for restoration of back-up configuration.

END OF SECTION 281400

SECTION 283100 – FIRE ALARM EMERGENCY VOICE COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the schematic design drawings and related construction documents including General and Supplementary Conditions and Division 01 General Requirements, shall be included in and made part of this Section.

B. Related Sections:
1. Division 01 General Requirements
2. Division 07 Thermal and Moisture Protection, Section 078413 Penetration Firestopping
3. Division 08 Openings, Section 087100 Door Hardware
4. Division 21 Fire Suppression
5. Division 23 Heating Ventilating and Air Conditioning Monitoring & Control (HVAC).
6. Division 26 Electrical, Section 260500 Common Work Results for Electrical

1.02 DESCRIPTION OF WORK

A. This section describes an addressable Fire Detection and alarm signaling system. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques to form a complete coordinated system ready for operation. Equipment quantity and locations shall be furnished per the contract documents and installed in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project.
   a. The system platform shall be a Siemens Desigo fire alarm with voice notification approved for an IBC E-occupancy.
   b. Work includes impairing any existing active system to accommodate phased installation of the new work.
   c. Support capability to monitor activity and remotely view information from a PC with the appropriate hardware and software.
2. The system shall be a new addressable fire detection and voice signaling system in accordance with the schematic design drawings. It shall utilize distributed modular control panels that utilize digital communications to provide optimal fault-tolerance and support future modification and expansion with a minimum of future wiring and hardware additions, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by the successful contractor. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project.
3. The system shall be scalable in nature and shall permit expansion of both capacity and functionality. It shall include all necessary hardware, software and peripheral devices to perform the following functions, but not limited to:
   a. Fire and smoke detection
   b. Manual alarm activation
   c. Occupant audible, visual and auxiliary notification

d. Automatic and manual one-way emergency and mass notification voice communications
e. Life safety functions to include:
   1) Elevator Service
   2) Smoke door release service
f. Integration with and status monitoring of related systems as required and specified:
   1) Fire protection suppression systems
   2) HVAC and building automation systems (BAS)
g. Report system events to the Listed Supervising Station via the approved means.
h. System programming and re-programming of all changes as necessary to accommodate the phased construction, alteration and demolition activities.

4. The system shall be installed per the Engineer of Record's schematic design drawings, project specifications and installed in full compliance with National, State and local Codes. These published editions of following reference standards shall be used in system design, installation, operation and maintenance unless the applicable legally referenced standard provides more stringent requirements:
   a. Pennsylvania Uniform Construction Code - International Building Code 2015 Edition
   b. Pennsylvania Electrical Code – National Electric Code 2015 edition.
   c. Underwriters Laboratories (UL) Listings.
   d. West Chester Area School District requirements.
   e. Americans with Disabilities Act (ADA), the Architectural Barriers Act (ABA), and Accessibility Regulations of the local jurisdiction.
   f. Applicable FM Global (Factory Mutual) Property Loss Data sheets.
5. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the schematic design drawings, whether or not specifically itemized herein. All devices installed outdoors or within areas exposed to unconditioned spaces or wet locations shall be listed for "outdoor use". Electrical raceway, fittings and enclosures shall be NEMA Type 4.
6. All equipment furnished shall be new and the latest state-of-the-art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over 20 years.
7. Provide the services of qualified system designers to generate shop drawings, and field technicians to provide installation oversight during construction and system startup. Technicians shall inspect, program, test and make any necessary adjustments to the completed system, to ensure compliance with the manufacturer's recommended practices and the approved shop drawings.
8. The system as specified shall be supplied, installed, tested and approved by the local Authority Having Jurisdiction, and turned over to the owner in an operational condition.
9. In the interest of job coordination and responsibilities the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests. All control panel assemblies and connected field appliances shall be provided by the same system supplier and shall be designed and tested to ensure that the system operates as specified.

10. The system specified shall be that of Siemens Industry, model Desigo Compact which meets the project requirements and in compliance with the West Chester Area School District's Comprehensive Plan. Being listed as an acceptable Manufacturer in no way

relieves obligation to provide all equipment and features in accordance with these specifications. All references to manufacturers model numbers and other pertinent information herein is intended to establish minimum standards of performance, function, and quality. Alternate products must be submitted to the Engineer two weeks prior to bid for approval. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification. All system approved shall meet all the requirements spelled out in this specification. System approval shall be in writing by the Engineer and a copy shall be submitted with the system submittals.

a. For equipment procurement contact Brian Urion, Siemens Industry, Inc. 1450 Union Meeting Road, Blue Bell, PA. 19422. Mobile: (215) 317-8683, Email: brian.urion@siemens.com

11. Strict conformance to this specification is required to ensure that the installed and programmed system will function as design and will accommodate the future requirements and operations of the building owner. All specified operational features must be met without exception.
12. All wiring shall be new and shall be fire-rated red MC cable.

1.03 DEFINITIONS AND ACRONYMS

A. Acoustically Distinguishable Space (ADS). An emergency communications system notification zone, or subdivision thereof, that might be an enclosed or otherwise physically defined space, or that might be distinguished from other spaces because of different acoustical, environmental, or use characteristics, such as reverberation time and ambient sound pressure level.

B. AHJ: Authority Having Jurisdiction, the individual or agency that has legal responsibility for reviewing the design for conformance with local codes and regulations.

C. ASME: American Society of Mechanical Engineers.

D. Beneficial Use: This shall mean that the Owner's operators are able to use the facility and receive reliable information therefrom in their normal work schedules for all inputs and outputs in this system network in which this Contractor has completed work.

E. Broadcast Media: The speakers, radio, cell phone, and other media that will carry the selected message to the selected audience.

F. EoR: The Engineer of Record responsible for the Schematic Design drawings and project specifications

G. ERRCS: Emergency Responder Radio Communications System also known as a Public Safety or First Responder DAS (Distributed Antenna System).

H. FACP: Fire alarm control panel.

I. FM: FM Global (Factory Mutual).

J. Furnish: To supply the stated equipment or materials.

K. Install: To set in position and connect or adjust for use.

L. LED: Light-emitting diode.

M. LOC: Local Operating Console.

N. MNS: Mass Notification System.

O. NAC Booster: Notification Appliance Circuit audio and/or visual auxiliary power supply controlled and supervised by the FACP

P. NFPA: National Fire Protection Association. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

Q. NICET: National Institute for Certification in Engineering Technologies.

R. Schematic design drawings: drawings which establish the objectives and design criteria of the system along with locations of fire alarm equipment, a system concept riser diagram, identification of interface(s) required with fire safety functions, and identification of all initiating device and notification appliance locations.

S. Provide: To furnish and install the stated equipment or materials.

T. UL: Underwriters Laboratories.

1.04 PERFORMANCE-BASED DESIGN REQUIREMENTS

A. The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system. The voice evacuation system amplifiers shall be configured as either bulk or distributed audio. Provide a multi-channel system if sequence of operations requires partial evacuations. Strobes shall be synchronized throughout the entire building.

B. Provide electrical supervision of the primary power (AC) supply, presence of the backup battery status, battery voltage, and system modules within control panels.

C. Fire alarm technicians must be able to perform comprehensive tests on the system with minimum disruption to occupants. Fire alarm system control must originate from the control panel and/or programmable field devices. Individual bypass switches located at the main control panel must provide system wide bypass for each type of output to accommodate testing with minimal disruption.

D. Field located transponders, NAC power booster panels, and terminal cabinets as required to support the project, if locations not specifically provided on the design drawings. Good access must be provided for testing and maintenance requirements.

E. NFPA 72 10.4.4 require smoke detection coverage above critical fire alarm components. The quantity of required NAC booster panels vary between manufactures and their installation location(s) are determined by the Installation Contractor. If area smoke detection is not provided in the vendor-selected NAC booster panel location, then a dedicated smoke detector shall be provided above the panel. These locations shall be shown on the installation shop drawings and approved by the EoR and AHJ prior to installation.

F. SLC Circuit Design: Ground Fault Detection
   1. For addressable loops, ground fault detection shall be employed which can detect a ground fault on both the positive and negative side of each circuit. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground faults shall not interfere with normal operation, such as alarm, or other trouble conditions.
   2. In compliance with NFPA 72, section 23.6.1, provide fault isolation for every 50 devices on any SLC, limited to a maximum area of a floor or fire/smoke barrier compartment boundaries. Provide separate ground gault detection for each floor/ level.
   3. A single fault on a pathway connected to the addressable devices shall not cause the loss of the devices in more than one zone or area. If a floor of the building is subdivided into multiple zones by fire or smoke barriers and the fire plan for the protected premises allows relocation of occupants from the zone of origin to another zone on the same floor, each zone on the floor shall be considered a separate zone.
   4. Dedicated isolator modules or ground fault detection integrated into an addressable device may be used to ensure
   5. Acceptable wiring designs
      a. Install SLC loops with no more than 50 addressable devices circuit, homeran back to the panel. Each SLC must be internally isolated from shorts.
      b. Provide field circuit isolation with loop isolator devices installed as the first device and keeping the isolated legs of the circuit to fewer than 50 devices.

G. Initiating Device Installation
   1. Coordinate smoke detector locations with ceiling diffusers; none maybe closer than 3 feet.
   2. For ceiling tile applications, center detectors in the tile, inline with other ceiling fixtures.

1.05 SEQUENCE OF OPERATIONS

A. Alarm Sequence of Operation:
   1. Activation of a manual fire alarm box, automatic detector, or fire suppression system shall initiate the system to enter “alarm” mode including the following operations:
      a. Flash local LED red on the associated addressable device.
      b. Provide local English language annunciation of device location, address and condition, and audible and visual alarm signal at control panel and remote annunciators.
      c. Provide manual "acknowledge" function at control panel to silence audible alarm signal, visual signal remains displayed until initiating alarm is cleared.
      d. Transmit “alarm” signal to off-premises equipment to notify monitoring company.
      e. Activate fire alarm notification appliances.
      f. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

B. Supervisory Sequence of Operation:
   1. Flash local LED red on the associated addressable device.
   2. Activation of gas detection, fire sprinkler tamper, pressure switch, duct mounted smoke detector or residential smoke detector with local audible base causes system shall initiate the system to enter "supervisory" mode including the following operations:

a. Provide local English language annunciation of device location, address and condition, and audible and visual supervisory signal at control panel and remote annunciators.
b. Provide manual "acknowledge" function at control panel and remote annunciators to silence audible supervisory signal, visual signal remains displayed until initiating supervisory is cleared. If AHJ approved, a supervisory condition may be programmed as self-restoring.
c. Transmit "supervisory" signal to off-premises equipment to notify monitoring company.
d. For HVAC smoke detection applications: transmit signal to shut down air associated air handling unit and close associated fire/smoke dampers.
e. For CO area detection applications: activate local NFPA 72 temporal-4 notification tone.
f. For HVAC CO detection applications: transmit signal to shut down air associated air handling unit and close associated fire/smoke dampers.

C. Trouble Sequence of Operation:
1. System trouble, including single ground or open of supervised circuit, or power or system failure, initiate the system to enter "trouble" mode including the following operations:
a. Flash local LED amber on the associated addressable device.
b. Provide local English language annunciation of device location, address and condition, and audible and visual trouble signal at control panel and remote annunciators.
c. Provide manual "acknowledge" function at control panel and remote annunciators to silence audible trouble signal, visual signal remains displayed until initiating trouble is cleared.
d. Transmit "trouble" signal to off-premises equipment to notify monitoring company.

1.06 SYSTEM INSTALLATION

A. This system is being installed as part of a new construction project and shall be harmonized with the other trades and any construction phasing schedules. Coordinate with all other Trade Contractors for the mounting of and/or interfacing with any and all other fire alarm system-related devices. Work and/or equipment provided in other divisions and related to the fire alarm system shall include, but not be limited to:
1. Duct smoke detectors are to be installed in coordination with Division 23 of the specifications. The devices shall be furnished, wired and connected to the fire alarm system by this Contractor.
2. Sprinkler water flow alarm and valve tamper switches are to be provided and installed by the Fire Protection Sprinkler Contractor under Division 21 of the specifications. They shall be wired and connected to the fire alarm system through addressable interface modules furnished by this Contractor.
3. Elevator recall control circuits shall be coordinated with the elevator control equipment. They shall be wired and connected to the fire alarm system by this division in locations approved by the Elevator Contractor. Provide all initiating devices, including alarm verification-type Elevator Lobby and Elevator Machine Room smoke detectors.
4. BATC system wiring of fire alarm system addressable relays and input modules to provide shutdown or start of required fans, air handling equipment, etc., and actuating fire and/or smoke dampers used for smoke control systems. Interface between BATC

system and fire alarm system, as well as required fire alarm system programming by this Contractor. Coordinate physical connection type and location with BATC Contractor.

5. Fire protection subsystems (Ansul, preaction, etc.) are to be provided under another division. Provide all required fused cutouts and communications interconnections with the base building fire alarm system.

1.07 FIRE CONTROL PANEL – The system shall be a complete, electrically supervised fire detection and notification system, with a microprocessor based operating system having the following capabilities, features, and capacities:

A. The system shall be complete, electrically supervised evacuation system using one-way communication with microprocessor-based operating system having the following capabilities, features and capacities:
   1. Listed for emergency and non-emergency use.
   2. Listed for MNS from any control point to 'Request/Grant/Deny' and integrated with FC2025-2050 and FV2025-2050 (no separate MNS panel)
   3. Ability to support up to two microphones per FV2025-2050 control panel for one-way paging, and up to 64 microphones in a voice network.
   4. Ability to provide manual voice control.
   5. Two channel message player supporting 300 messages (38 pre-recorded). The system supports MP3 and WAV files.
   6. Minimum of (2) simultaneous audio channels for each networked panel.
   7. Amplifiers shall be rated for 25V or 70.7V RMS, 50 watts. Voice amplification shall be supervised and backed up with like amplifiers. Back up shall be one or two per node.
   8. Ability to provide separate booster amplifier. Amplifiers shall be rated for 25V or 70.7V RMS, 100 watts.
   9. The system shall have the capability to support Peer-to-Peer or Master-Slave network and voice configurations.
   10. Multiple nodes shall provide peer-to-peer voice capability in order to eliminate a single point of failure.
   11. Audio shall be synchronized between nodes in order to take into account common areas.
   12. Speakers shall have the ability to play coded audio tones.
   13. The system shall provide status indicators and control switches for all of the following functions:
      a. Audible and visual notification alarm circuit zone control.
      b. Speaker circuit zone control.
      c. Status indicators for sprinkler system water flow and valve supervisory devices.
      d. Remote Alarm Transmission By-pass Switch: Shall prevent transmission of all signals to the main fire alarm control unit when in the "off" position. A system trouble signal shall be energized when switch is in the off position.
      e. Drill Switch: Shall activate all notification devices without tripping the remote alarm transmitter. This switch is required only for general evacuation systems specified herein.
      f. Door Holder By-Pass Switch: Shall prevent doors from releasing during fire alarm tests. A system trouble alarm shall be energized when switch is in the abnormal position.
      g. Elevator recall By-Pass Switch: Shall prevent the elevators from recalling upon operation of any of the devices installed to perform that function. A system trouble alarm shall be energized when the switch is in the abnormal position.

h. HVAC/Smoke Damper By-Pass: Provide a means to disable HVAC fans from shutting down and/or smoke dampers from closing upon operation of an initiating device designed to interconnect with these devices.

14. Each intelligent addressable device or conventional zone on the system shall be displayed at the main fire alarm panel and each local fire alarm remote annunciator by a unique alphanumeric label identifying its location.
15. The system shall be capable of remote monitoring via a proprietary software system that provides a graphical representation of the fire alarm control panel at a remote PC when connected via Ethernet to the system. The display will show the exact state of the panel, including blinking LEDs, and with menu buttons for control.
16. In networked systems, each of 4 control panels shall be configurable to be a global annunciator, capable of viewing all other control panels on the network.
17. The system shall provide an off-normal warning prior to reset for all active devices.
18. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested.

B. The system shall be complete, electrically supervised voice evacuation system having the following capabilities, features and capacities:
1. Amplifiers shall be rated for 25V or 70.7V RMS.
Amplifiers shall be sized as minimum, to accommodate speakers in mechanical spaces at 2 watts and other locations 1 watt. Minimum 25% space capacity.
2. Audio shall be synchronized between panels in order to take into account common areas.
3. The network, and audio, risers between nodes shall be copper and support Class A loop configuration to allow communication to continue in the event of a fault.
4. Speakers shall have the ability to play both voice and coded audio tones, including low frequency 520Hz required for sleeping areas.
5. The system shall provide status indicators and control switches for all of the following voice functions:
a. Audible and visual notification alarm circuit zone control.
b. Speaker circuit zone control.

1.08 CIRCUIT AND PATHWAY PERFORMANCE REQUIREMENTS

A. Circuits and Pathways
1. This project’s notification sequence is for complete (total) evacuation upon any general alarm condition. NFPA 72 Pathway survivability is not applicable.
2. Addressable Signaling Line Circuit (SLC) wiring shall be configured as Class B circuits, with a minimum Level 1.
a. SLC wiring shall utilize fault isolation modules so that a single wiring fault on the conductors serving one floor or evacuation signaling zone will not affect the operation of devices serving any other zone.
b. SLCs shall not exceed 75% of the number of each type of device the circuit is capable of supporting.
3. Visual Notification Appliance Circuit (NAC) wiring shall be configured as Class B circuits.
a. The actual number of circuits to be installed shall be coordinated with the supplier's shop drawings. Appliance circuits shall be zoned to correspond with the building fire barriers and other building features.

4. Speaker Notification Appliance Circuits (NAC) shall be configured as Class B circuits. Appliance circuits shall be zoned to correspond with the building fire barriers and other building features. The system shall be provided with the minimum listed speaker circuits as follows:
    1) Minimum (1) speaker circuits for each evacuation signaling zone or smoke compartment; whichever is greater.
    2) Speaker circuits shall be individually selective by evacuation signaling zones and shall be zoned to correspond with the building fire barriers and other building features.

B. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals and trouble signals shall be logged on the system printer and in system history during the walktest.

C. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

1.09 SUBMITTALS

A. The equipment supplier responsibilities will include the selection of equipment, devices and materials based on the schematic design drawings and project requirements, and their proper application based on the manufacturer’s limitations, operating characteristics and recommended practices.
    1. Equipment quantities and locations shown on the schematic design drawing floorplans shall not be altered or modified without written approval of the Engineer of Record. Any deviation from the Engineer’s coordinated layout or design intent will constitute the submission as incomplete and shop drawings will not be approved.
    2. Minor deviations, variations, changes, and corrections from layouts shown on the drawings (based on coordination, conditions, manufacturer's instructions, codes and standards, shop drawings, and verification of measurements and conditions) are permitted to facilitate construction provided the changes do not represent potential changes in scope of work and provided the changes are acceptable to the owner, architect, and engineer.
    3. The equipment supplier shall coordinate the installation and system operation with the work of related trades.

B. Catalog manufacturer’s product data sheets for all equipment, accessories and wiring with all applicable components being submitted for this project clearly noted. All equipment shall be subject to approval and no equipment shall be ordered without prior approval.
    1. Data Sheets with multiple product shall highlight or identify the specific products utilized for this project.

C. System Calculations - Circuit calculations shall use the end-loading or point-to-point method described in NFPA recommended practices including both standby and active conditions. Complete calculations shall be provided which show the electrical load for all equipment and field circuits. (identify all mathematical formulas, variables, and constants used in all calculations) on the following system components:
    1. Voice amplifier wattage, speaker loads and spare capacity.
    2. Strobe 24VDC loads and spare capacity.
    3. Show wire size, estimated circuit length, and maximum allowable wiring distance as designed. Voltage drop calculations for wiring runs demonstrating worst-case condition.

4. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
5. NAC circuit (audible and visual) design shall incorporate a 20% spare capacity for future expansion.

D. The shop drawing submittal shall clearly indicate all proposed equipment and devices (type and quantity), with wiring diagrams, detailed operational sequences, and interfaces to related systems. They shall be prepared in accordance with NFPA 72 recommended practices and include the following:
   1. Floor plans showing all devices and equipment to be installed with corresponding field settings, circuit, and device designations noted. Settings shall include the device address and candela rating as applicable. Circuit identifiers, device numbers and symbols used shall be clearly defined and consistent between all related documents. Whenever possible, the drawings shall reflect other components of the building such as air diffusers, HVAC returns, etc. to determine compliance or reference the associated mechanical design drawings.
      a. Floor plans at a scale of 1/8”=1’-0”
      b. When candela ratings are not shown on the schematic design drawings, utilize NFPA 72 visual coverage area tables to select coverage.
   2. Complete point-to-point riser diagrams showing all equipment including size, type, number and reference designations for all circuits and devices. Each device shall be shown with address numbers or any other required field device settings including candela rating of notification appliances.
      a. For multiple panel configurations, proved a separate block diagram to show the overall network system architecture with interconnection network circuits.
   3. System panel drawings showing cabinet dimensions, internal module placement, field wiring terminations with spare capacity allowances, and any applicable operator's display and panel switch label assignments. Where multiple equipment cabinets are used in a single location these shall be shown together in elevation for coordination of equipment installation and wireways, and to ensure proper space allocation.
   4. Provide a complete sequence of operation in the form of an NFPA lnput/Output programming matrix for the entire system as shown in NFPA 72. The matrix shall reflect each unique programmed sequence, whether the sequence is initiated by an individual or common group of similar devices. Matrix shall illustrate alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions.
   5. Installation drawings shop drawings, and as-built drawings shall be prepared by a NICET II or higher individual experienced with the work specified herein.
   6. Incomplete submittals shall be returned without review, unless with prior approval of the Engineer.
      a. Disposition of shop drawings shall not relieve the Contractor from responsibility for deviations from drawings and specifications, unless the deviations are specifically noted in writing at the time of submission, and written acknowledgement has been received from the Engineer or Record. The disposition of shop drawings shall not relieve the Contractor from responsibility for errors in shop drawings or schedules.
      b. Copies of the approved shop drawings shall be maintained on-site to serve as working documents during installation for preparing as-builts.

E. Delegated Design Review of Shop Drawings: As required per the AHJ, in addition to items listed above, provide a compliance and code review by an individual with the required credentials and submit documentation, including any evaluation analysis of the shop drawing submittal. Provide the required review's credentials and seal/ signature by the qualified professional engineer responsible for the preparation, as required. The equipment supplier's shop drawings shall not be stamped or sealed by an Engineer unless the work is performed under their direct supervision and control.

1.010 QUALITY ASSURANCE

A. The following shall be adhered:
   1. State and Local Building Codes as adopted and/or amended by The Authority Having Jurisdiction, ADA, and/or State and local equivalency standards as adopted by The Authority Having Jurisdiction.
   2. Owner's best practices for fire alarm installations/ operations including compliance with site standard operating procedures (SOP's).

B. Equipment Supplier Qualifications

   1. The supplied products must utilize multi-channel product distribution on a national basis to be considered for this bid. The distribution shall be from factory branches as well as independent distributors to allow the end user with the ability to utilize factory trained and authorized competitive service providers after system installation and commissioning. Single source system suppliers are not acceptable. The initial installation and commissioning shall be provided by a factory direct branch to ensure a high level of quality for the customer.
   2. The equipment as specified shall be supplied by Siemens Industry. For equipment procurement contact Brian Urion, Siemens Industry, Inc. 1450 Union Meeting Road, Blue Bell, PA. 19422. Mobile: (215) 317-8683, Email: brian.urion@siemens.com
   3. Shall be licensed in the jurisdiction, if required.
   4. The equipment supplier shall have a licensed fire protection engineer on staff to assist with all aspects of the installation including interfacing with the local AHJ and code consulting.
   5. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
   6. The Equipment Supplier shall have in-house engineering and project management capability consistent with the requirements of this project. Factory trained representatives of the system manufacturer shall perform the detailed engineering of the system.

C. Installer Qualifications:
   1. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
   2. The contractor shall submit copies of all required licenses and bonds as required in the State having jurisdiction.
   3. The system installer shall work with the system supplier/designers to ensure all equipment is installed as shown in the Shop Drawings and manufacturer's requirements, and programmed to comply with the project requirements.

4. The installing contractor is responsible for coordination with related trades, and complete (1st party) testing of the system as installed, to include verification that the system performs as intended, and all devices and fault conditions are properly supervised and reported as specified herein.

D. Testing Agency Qualifications: Qualified for testing indicated.

E. Source Limitations for fire alarm equipment: Obtain fire alarm equipment from single source.

1.011 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.

B. Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

1.012 PROJECT CONDITIONS

A. Installed products or materials shall be free from any damage including, but not limited to, physical insult, dirt and debris, moisture, and mold damage.

B. Environmental Limitations: Do not deliver or install products or materials until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.013 WARRANTY

A. The equipment and wiring shall be warranted to be free from electrical, mechanical and performance defects, within the specified warranty period. Equipment and components that fail in materials or workmanship must be repaired or replaced. It shall include all labor/travel time, parts and programming. The warranty also provides for the adjustment of smoke detector sensitivities due to unwarranted or nuisance detector activations.
   1. Warranty Period: One year after substantial completion of final project phase.
   2. Warranty Initiation: Commencing with start-up and owners beneficial use of substantial completion of final project phase.
   3. Warrant the continuous future availability of service for this system. The servicing shall be provided by a factory-trained service representative.
   4. The warranty does not cover cases involving component failure due to abuse, misuse, and/or "Acts of God" including but not limited to lightning strikes, flooding, power surges, and fire.
   5. This warranty is void if the product is altered, repaired, or serviced by anyone other than original equipment installer.
   6. A copy of the manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.

B. All labor for administering and servicing the warranty, including actual replacement of parts, will be the responsibility of the Installer for the warranty period.

C. This Warranty does not apply to the replacement of consumable parts such as internal standby batteries. These components are designed to diminish over time unless failure has occurred due to a defect in materials, equipment malfunction, or expose to ambient conditions beyond their UL listing. As with all batteries, the maximum capacity and performance of the battery will decrease with time and use; this is not a defect. The expected lifespan of a fire alarm battery under normal conditions is 3 years. Only defective batteries and batteries that leak are covered by this warranty.

D. The Owner reserves the right to make changes to the fire alarm system during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any such changes made by Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the fire alarm system.

1.014 SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for 1 year.

B. Upgrade Service: Update software, firmware, to latest version at project completion. Install and program software upgrades that become available within one year from date of substantial completion. Upgrading software, firmware shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.015 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. The following spare devices shall be supplied as applicable to this project:

1. Two (2) keys for each locked or tamper proofed cabinet.
2. Two (2) percent smoke detectors device(s).
3. Two (2) of each type of smoke detector installed.
4. Two (2) of each type of heat detectors installed.
5. Two (2) of each type of pull stations installed.
6. Two (2) of each type of standard notification appliance(s) (speaker, strobe & combination) installed.
7. Two (2) of each type of replaceable surge suppression modules installed.
8. Two (2) of each type of replaceable fuses installed in the system. Provide in a box or cabinet with compartments marked with fuse types, sizes and equipment locations.
9. One year of filters for Air-Sampling Detectors, per the manufacture’s recommended service schedule.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: Siemens Desigo

1. Alternate Manufacturers:
   a. Siemens Cerberus Pro
   b. Simplex 4100ES
   c. Refer to 16000 for substitution requirements

B. The equipment and service described in this specification are those supplied and supported by Siemens Industry and represent the base bid for the equipment.

1. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.

C. Must have multi-channel distribution for both products and equipment service. The owner shall have the ability change service provider or sales outlets. Proprietary manufactures such as single-channel suppliers are not acceptable.
1. The initial installation shall be completed by a factory direct office.

2.02 CONTROL PANEL

A. The fire alarm control panel shall be microprocessor-based using multiple microprocessors throughout the system, providing rapid processing of smoke detector and other initiation device information to control system output functions.

B. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal and reset the panel.

C. The signal line circuits (SLC) shall be polarity insensitive for all addressable devices. This permits the fire detection devices to operate even when detector and module wiring polarity are inverted on the wrong screw terminals.

D. The standard Operator Interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked Desigo Fire Safety control panels, when configured as a global PMI. The standard operator interface can acknowledge, silence, and reset panels via Global PMI.

E. System response time from alarm to output shall be an average of three (3) seconds.

F. To expedite system troubleshooting, the system cards shall have ground fault detection and diagnostic LEDs by card.

G. All system cards and modules shall have Flash memory for downloading the latest module firmware.

H. Passwords:
1. Maintenance/Control Password - There shall be a 5 character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions.

I. Networking – Command and Control:

1. A bidirectional data communications network transmitting multiplexed input and output signals, which shall be electronically supervised, shall connect all control panel nodes on

a dedicated fire alarm network. The communication network shall consist of a communication circuits transmitting all system operations in a digitally encoded format.

2. Digital two-way communication capabilities supporting Style 4 (Class B) or Style 7 (Class A) communications using either hard-wired copper or fiber optics technologies or combinations of both as required for the control panels to communicate.
3. The system shall be designed such that in the event of a network communications failure, any remaining interconnected panels will operate as a sub-network and any isolated panels will operate in standalone mode. Upon communications failure, a trouble condition will be reported across the network and the disconnected panel shall continue to function in standalone mode.
4. Capability shall exist within the system to extend the network at any node. The system shall support a maximum of two network extension circuits in series on any system branch, extending the inherent distance limitations for network communications.
5. Communication protocol shall be of the CSMA/CD (carrier sense, multiple access, collision detect) type, eliminating delays incorporated into other protocols. Communication techniques using token passing and requiring sensing of delays and re-generation of the token to re-establish network communications in the event of a fault shall not be acceptable.

J. Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of external programmers or change of EPROMs are not acceptable.

K. Mass Notification Non-fire Interface: The fire alarm control panel shall be capable of connection to external and internal building paging subsystems UL2572 Mass Notification system.

1. In additional to the FACP microphone, the Voice Evacuation/Mass Notification panel shall have the ability to support optional auxiliary remote live-voice sources:
   a. Local Operator Console with remote microphone with controls
   b. Remote Page Unit utilizing 3-party public address system
   c. Telephone/ PBX interface
2. Ability to interface with wide-area mass notification (outdoor high-powered speaker arrays) to provide real-time information to exterior areas.

L. Logic: The fire alarm system shall support generic functions that deal with binary states (True/False, high/low), and produce desired outputs from one or more binary inputs (for example, alarm outputs from spot detectors, VESDA detectors, monitor modules or manual station inputs). AND, OR, NOT, Any N, D Latch, RS Latch, Time Base Control, Start Timer, Restart Timer are generic functions. Generic functions can be used as inputs to other function. The system shall support 2500 logic functions.

M. History: The system shall store 5000 events in history while in straight mode and 4500 in circular mode. In straight mode, trouble warnings will occur at 4000 and 4500 events. In circular mode, the control panels shall maintain a 2000 event Alarm History buffer, which consists of the 2000 most recent alarm events from the 4500 event history file.

2.03 PRIMARY POWER SUPPLY

A. The control panels, transponders, NAC power booster panels, system workstation, and any other fire alarm equipment shall receive their primary power from a dedicated 120VAC disconnect circuit.

1. The circuit must be properly sized and protected in accordance with NEC requirements.
2. This requirement does not limit that one dedicated branch circuit to serving only one power supply within a system. The dedicated branch circuit could supply several fire alarm power supplies within a control unit or within multiple interconnected control units that serve the signaling system.
    a. The dedicated circuit can be supplied from any properly installed electrical panel board or sub-panel.
3. The circuit disconnecting means shall be labeled 'FIRE ALARM' and any other local identification requirements. Its location must be listed at the point of connection to the fire alarm control equipment. Provide a dedicated breaker lock unless the breaker is located in locked panel board or if it is in a locked electrical room.
4. For high-rise applications, the 120VAC power circuit must be on emergency power for code compliance.

B. The fire alarm control panel and transponder panel power supply/charger (PSC) shall be a 12-amp supply with battery charger. The power supply shall be filtered and regulated. The power supply shall have a minimum of 1 power limited output rated at 4 amps, and a minimum of 1 output rated at 12 amps. Each panel shall have the capacity to be expanded up to 48 amps. The auxiliary power supply module shall share common batteries with the primary power supply. The system power supply shall have 4 relays, 1 for common alarm, one for common trouble and two programmable relays. The power supply shall be rated for 120/240V AC 50/60 Hz.

1. Provide sufficient capacity to operate the complete alarm system and 100% of the notification appliances in alarm operated at the same time, under both the primary (AC) power conditions. Under no circumstances shall the power supplies exceed a MAXIMUM of 70% of the power supplies battery capabilities throughout the entire project.
2. The primary power supply shall be sized be the equipment vendor
3. The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed with an optional thermistor for monitoring battery temperature to control charging rate shall be available. All battery charging and recharging operations shall be automatic.
    a. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
4. The power supply shall have a plug for an AC adapter cable, which allows a technician to plug in a laptop computer for up or down loading program information or test equipment.
5. Transfer from AC to battery power shall be instantaneous when AC voltage drops less than 90% or brown out conditions it is not sufficient for normal operation.

C. Loss of primary AC power shall sound a trouble signal at the FACP. The FACP shall indicate when the system is operating on an alternate power supply.

2.04 SECONDARY POWER SUPPLY

A. When the primary AC power is lost, the system shall automatically switch to the secondary power supply.

B. The control panels, transponders, and NAC power booster panels shall receive their secondary power from batteries.
   1. Battery shall be of the sealed lead-acid, maintenance free type, 24-volt nominal, suitable for life safety application.
   2. Provide sufficient capacity to operate the complete alarm system in quiescent standby load (system operating in a non alarm condition) for a period of 24 hours and shall have sufficient capacity to operate all alarm notification appliances and all other connected loads for a period of 15 minutes.
   3. Batteries shall be secured in seismic areas 2B, 3, or 4 as defined by the Building Code.

2.05 SYSTEM ENCLOSURE

A. The control unit shall be housed in a cabinet suitable for both recessed and surface mounting. Cabinet and front shall be corrosion protected, given a rust resistant prime coat, and manufacturer's standard finish. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.

B. Enclosure needed to hold all the cards and modules as specified with at least 25% spare capacity for extra cards.

C. Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented.

2.06 DOCUMENT STORAGE BOX

1. With every new system, a documentation cabinet shall be installed at the system control unit or at another approved location at the protected premises. Where the documentation cabinet is not in the same location as the system control unit, its location shall be identified at the system control unit. It shall meet NFPA 72’s record maintenance requirements and the following criteria:
   a. Enclosure to accommodate standard 8-1/2-by-11 inch and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information.
   b. Provide two key ring holders with location to mount standard business cards for key contact personnel.
   c. Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
   d. Color: Red powder-coat epoxy finish.
   e. Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
   f. Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

2.07 INITIATING DEVICES

A. General

1. The initiating device shall provide an alarm indication within less than four (4) seconds.
2. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections.
3. Operating Voltage: 24 VDC, nominal.

B. Multi-criteria Smoke Detectors – Addressable

1. The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors' communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of 19 environmental fire profiles unique to the devices installed location.
   a. UL Listed as "direct in-duct" mounting.
2. Smoke detectors shall be analog sensors that utilize photoelectric-type sensing principles mounted within a smoke chamber to detect particles of combustion. They must provide at least 3 environmental parameter sets to assist the device sensitivity configuration.
3. The control panel shall continually analyze the analog signal from each sensor to determine calibration, sensitivity and environmental changes that may affect sensor operation. The analog values from each device shall be displayed (in terms of percent of obscuration) at the control panel upon command.
4. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm. Each detector shall include an LED that will flash periodically to indicate an active polling cycle. When the sensor reaches a predetermine alarm threshold (2% obscuration unless otherwise directed), the detector shall latch in LED shall flash continuously until reset at the control panel.
   a. The system shall have the ability to disable the detector's LED.
5. The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.
6. The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The outputs shall be from an input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
7. The detector shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes, and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
8. The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address.

9. Where indicated on the schematic design drawings, provide remote indicator lamps and identification plates for detectors concealed from view. Each indicator will illuminate when the detector is in alarm. Locate the remote indicator lamps and identification plates flush mounted on walls so they can be observed from a normal standing position in the nearest common corridor or otherwise designated on the floorplans.
10. The multi-criteria detector with CO sensor shall support the use of an ambient Carbon Monoxide (CO) warning signal at the panel. This ambient CO level shall be user-configurable in parts per million (PPM) for the set threshold of the warning and event type generated by the warning. This event can be used to trigger system logic.
11. The detectors shall support the use of an ambient temperature warning signal at the panel. This temperature shall be user-configurable for the set temperature of the warning and the event type generated by the warning. This event can be used to trigger system logic.

C. Heat Detectors – Addressable

1. Thermal Detectors shall be analog/addressable sensors individually programmable for either fixed temperature, rate-of-rise or combined operation, except where otherwise dictated. The thermal detector shall be Model FDT421 and have the following temperature settings:
   a. Fixed temperature at 135°F, 145°F, 155°F, 165°F, 174°F
   b. Rate of Rise at 15°F/ min at 135°F
   c. Rate of Rise at 15°F/ min at 174°F
2. Analog sensors will also provide a low temperature warning (Supervisory condition) when the ambient temperature in a protected area reaches 40 degrees F.
3. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm. Each detector shall include an LED that will flash periodically to indicate an active polling cycle.
4. Where ambient conditions dictate, provide conventional fixed temperature, weatherproof or explosion-proof heat detectors in lieu of analog detectors. Conventional devices shall be individually addressable via a dedicated addressable monitor module which shall be installed in an appropriately heated, ventilated location.
5. The detectors furnished shall have a listed spacing for coverage on smooth ceiling rating of up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.

D. Duct Smoke Detectors – Addressable

1. The system supplier shall select the appropriate detector type, quantity and environmental configuration based on the manufacturer limitations, code requirements and the project HVAC system operating characteristics for air flow, velocity and environmental conditions.
2. Photoelectric type FDBZ-Series, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Where required there shall be available a duct housing with an on-board relay for fan shutdown.
   a. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.

b. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator.
c. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
d. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
e. Duct smoke detector housing shall allow use in duct systems with air velocity ranging from 100 to 4,000 feet per minute, within temperature ranges of 32°F to 120°F per minute, and with relative humidity ranging from 0 to 95%.

3. Provide a remote LED indicator associated with the duct detector, as shown on the design drawings
4. Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. A NEMA-3R and NEMA-4X option shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.
5. Traditional area detectors may be substituted on ducts with access hatches within the manufacturer's limitations and applicable standards. When mounted directly in the HVAC air stream, detectors shall be rated for airflows ranging from 0 – 1000 feet per minute. Utilize pendant mounting to get the device in the center of the air flow. It must be mounted to an appropriate electrical box mounted rigidly to withstand the pressure and resonant vibrations caused by the air velocity. The box pendant extension arrangement should be mounted from either the top or side walls extending to the center of the air duct stream. The access hatch shall be labeled to identify both the detector and HVAC unit it protects.

E. Detector Bases – Addressable

1. The plug-in detector bases shall be UL compatible with the selected detector head. They shall utilize screw clamp terminals and field circuits shall terminate directly to the base. Bases shall be installed directly on an industry standard 3 1⁄2-inch, 4-inch octagon boxes, and 4-inch square boxes (with or without plaster). Position decorative ring around the base as required per the manufacture. Provide the ability to make the detector base tamperproof to prevent the removal of the detector head without the use of a tool.
   a. The standard DB-11 base shall be - 6" version.

F. Carbon Monoxide Detectors

1. Carbon Monoxide Detectors: Provide Analog/Addressable sensors that include a CO sensing element where shown and required. Detectors may be either standalone sensors, or employ multi-sensing technology integrated with smoke sensors, and shall be Listed to the appropriate ANSI/UL standards, including UL 2075 (carbon monoxide), UL 268 (smoke) and UL 521 (thermal) as applicable.
2. The CO element shall operate between 30-560 parts per million (ppm), with a standard set point of 70ppm for exposure of 60 minutes accordance with NFPA 720. CO Sensors shall operate on non-resettable 24vdc power provided by the FACP, and provide full analog values directly to the FACP. The detector shall have associated programmable control module outputs, and an integral piezo horn that produces 85dbA at 10ft. Activation of a CO Detector shall initiate a Priority 2 Supervisory CO Alarm event at the

local Control Unit and Fire Response Center, and remote system Annunciators as described herein.

3. Multi-Criteria Fire Detector Model FDOOTC441 shall be listed as providing CO detection in duct application.
4. CO Sensors that are integrated into Mechanical Systems shall be designed for duct mounting or area detection, with a CO Alarm set point of not less than 50ppm, and be appropriately Listed by a Nationally-Recognized Testing Laboratory.
5. Sensors shall be provided and installed in accordance with the manufacturer's instructions. Sensors shall be monitored by the local Fire Alarm System for multiple alarm thresholds with corresponding addressable outputs to initiate equipment shutdown procedures and related life safety functions. Sensors will support periodic functional testing.
6. CO Sensors shall be monitored and programmed for Supervisory CO Alarm reporting in accordance with NFPA 720 and applicable code.

G. Manual Pull Stations – Addressable

1. Provide double-action addressable manual stations where shown on the schematic design drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting unique numeric address, identity, alarm and trouble to the fire alarm control panel.
   a. Station will mechanically latch upon operation and remain so until manually reset by opening with a supplied alien wrench.
   b. Stations shall be of double action pull down type with suitable operating instructions provided on front in raised or depressed letters, and clearly labeled "FIRE".
   c. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Flying lead terminals are not permitted.
   d. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
2. Where shown on the schematic design drawings, provide a protective shield.
   a. Shall be constructed of a clear LEXAN shield and red frame that easily fits over manual pull stations.
   b. When shield is lifted to gain access to the station, a battery powered piercing warning speaker shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.
3. Where required, there shall also be available pull stations with break glass, capable of explosion proof installation, capable of weatherproof installation, reset key operation, and metal housings.

H. Addressable Monitoring and Control Modules

1. Addressable Interface Devices shall be provided to monitor contacts for such items as water-flow, tamper, and PIV switches connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive. The addressable interface modules shall be model number HTRI or FDCIO Series.

a. The modules shall support two operation modes: an isolator (polarity sensitive) or non-isolator (polarity insensitive) mode. The module shall be capable of being wired for either mode. During the isolator mode, the built-in dual isolators will work at both sides of the module to isolate the line short in front or behind the module.
   1) Supports up to 252 addressable points per SLC devices loop, and in mixed mode up to 30 devices between isolated devices

b. Modules shall support NFPA 72 survivability requirements for shorts and provide information as to the location of the fault.
c. Each Model XTRI-series device has a multi-color LED that flashes when GREEN operating in Normal mode; AMBER if the unit is in a `Trouble' condition, and RED to indicate a change of status.
d. Provide non-obstructive front-end access to programming port and wiring terminals.

2. Waterflow and tamper switches in the sprinkler systems and the tamper switches on valves for the sprinkler systems will be provided under the Fire Protection Division. Coordinate with Fire Protection Division as to the proper type and number of contacts required on the sprinkler water flow and tamper switch devices. These devices shall be connected to individually zoned, addressable modules.

3. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

   a. Report faults to the host FACP.
   b. On-board Yellow LED provides module status.
   c. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

2.08 DEVICE PROGRAMMING / TEST UNIT

A. The device programming unit is a tool used for installation, commissioning, maintenance and servicing of addressable devices. It shall program the intelligent devices with the assigned addresses and provide an electronic test to ensure proper operation. Programming dipswitches and/or rotary switches shall not be acceptable. The portable unit shall provide the following features:
   1. Liquid-crystal display (LCD) screen with keypad
   2. Built in addressable base as well as two external terminals for use with all other addressable ancillary devices.
   3. Powered from on-board standard NiMH' rechargeable batteries or standard 'AA' Alkaline battery or an external AC adaptor.
   4. Reads analogue values of addressable loops and preform maintenance features such as ground fault detection.
   5. nonvolatile Flash memory with ability to download software upgrades.

B. The equipment supplier shall furnish a device programming unit to the installer for the duration of the project.

2.09 NOTIFICATION APPLIANCES

A. General requirements: Provide combination or individual audible and visual notification appliances as shown and permitted. All appliances shall be direct-wired; devices that utilize a multi-part assembly with swipe or non-mechanical pressure-type contact connections will not be considered acceptable.

1. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
2. Appliances shall have no identifying labels and have a red or white finish as directed by the Architect.
3. The contractor shall provide fitted surface mount backboxes supplied by the appliance manufacturer and outdoor-rated appliances where site conditions dictate.

B. Audible Speaker Appliances:

a. Speaker appliances shall be SLSPC and SLSPSC series appliances or approved equals for maximum output (at minimum wattage) across a sizeable frequency range, 300 to 8000 Hz.

1) High-fidelity speakers UL Listed (for indoor use under Standard 1971 and 464).
2) Wall-mounted Speakers: Provide multi-tapped cone speakers with square or rectangular grille with where shown or required. Each speaker shall have selective 1/4, 1/2, 1, or 2 watt taps. Each speaker shall produce a sound output level of 84dbA at 10' (1 watt setting).
3) Ceiling-mounted Speakers: Provide multi-tapped cone speakers with 7” round white grille and the appropriate backbox/baffle and ceiling tile bridge assemblies for ceiling mounting where shown or required. Each speaker shall have selective 1/4, 1/2, 1, or 2 watt taps. Each speaker shall produce a sound output level of 84dbA at 10' (1 watt setting).

b. Provide high output re-entrant-type speakers with the appropriate weatherproof listings in outdoor or other high ambient noise areas, as shown on the schematic design drawings.

1) Multiple tap setting up to 15 watts.

c. Speakers shall be UL Listed under Standard 1480 for Fire Protective Service, and speakers equipped with strobes shall be listed under UL Standard 1971 for Emergency Devices for the Hearing-Impaired. Speaker with strobes shall be certified to meet the requirements of FCC Part 15, Class B.

d. All speakers shall be designed for a field-selectable input of either 25 or 70 VRMS.

C. Visual Strobe Appliances:

a. Visual-notification appliances shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service.
b. Strobe shall be listed for indoor use, and shall meet the requirements of FCC Part 15 Class B.
c. LED multi-candela strobe shall have field-selectable settings, and be rated per UL Standard 1971 for:
1) Wall-mount: 15/30/75/110cd
2) Ceiling mount: 15/30/75/95cd or 115/177cd ()

2. The LED portions of the strobes shall meet the 20 millisecond light-pulse duration requirements of the 2016 edition of NFPA 72.

3. All inputs shall be compatible with standard, reverse polarity supervision of circuit wiring by a Fire Alarm Control Panel (FACP)

4. The selector switch for selecting the candela shall be tamper resistant

5. The strobes shall not drift out of synchronization at any time during operation

   a. If the sync module or Power Supply fails to operate, (i.e. - contacts remain closed), the strobe shall revert to a non-synchronized flash rate

2.010 MAGNETIC DOOR HOLD OPEN DEVICES

A. Door Hold Open Devices: Door hold open devices shall be operate from 120VAC power. The Contractor shall coordinate the proper voltage of these devices with the door hardware supplier to ensure that all required hardware and wiring is provided

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.

B. Material and Finish: Match door hardware.

2.011 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush Surface cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.012 DIGITAL COMMUNICATOR

A. The commercial fire alarm off-site communicator shall provide general (alarm/ trouble/ supervisory) and ability for contact/ grouped event ID reporting from the fire alarm control panel (FACP). It shall be UL864 listed to provide point identification of alarm, supervisory, and trouble events to a Central or Remove Receiving Station. It shall offer three selectable reporting paths which include: Cellular only, IP only, or IP primary/cellular backup. The Comminutor shall receive its power and supervision from the FACP.
   1. For this project, utilize cellular communications as the primary means of communication, per NFPA 72 requirements. IP communications for owner selected/provided future option.

2. The dual path communicator shall be provided with a local cellular antenna. When the minimum cellular signal strength required by the manufacture's installation instructions cannot be met, provide an external antenna located and installed per field conditions, with the owners approval.
3. Cellular operates over the following communication protocols:
   a. HSPA+ (4G)
   b. HSPA (HSDPA &HSUPA) + (3G)
   c. EDGE (2G GPRS) (2G).
4. Selectable reporting paths and supervision intervals to meet NFPA 72, chapter 26 requirements.
5. Cellular provide capability: With broadest coverage footprint available in Verizon Network Certified™ or AT&T networks.
6. Future IP communication works over any type of customer provided Ethernet 10/100 based network connection (LAN or WAN), DSL modem or cable modem.
7. Shall supports both dynamic (DHCP) or Public and Private Static IP addressing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Perform work in accordance with the requirements of NFPA 70, NFPA 72, NFPA 13, NFPA 2001, and NECA , Standard of Good Workmanship in Electrical Contracting.

B. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.

C. In the event that limited energy cable installation is allowed, all cable runs shall be run at right angles to building walls, supported from structure at intervals not exceeding 3 feet and where installed in environmental air plenums, be rated for such use and tied/supported by components listed for environmental air plenums installation.

D. Backing Boards: Provide 3/4-inch marine plywood backing boards for support of all fire alarm equipment panels surface mounted on masonry walls.
   1. Paint both sides of boards with two (2) coats of Gray enamel, including all edges.

E. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

F. Wiring Integrity and survivability requirements – Specified on shop drawings per NFPA72, Chapter 12

G. Wiring Method: Contractor to utilize fire-rated red MC cable. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

H. Provide Surge Protection Devices (SPD) on all fire alarm wiring, which extends beyond the main building. Locate the SPD as close as practicable to the point at which the circuit leave or enter the building where the Fire Alarm Control Panel is located. Protection devices shall be shown on the schematic design drawings and shall be UL listed or in accordance with written manufacturer's requirements.

1. Provide equipment ground and connected to the building grounding electrode system per NEC.
2. Provide a dedicated enclosure to house the SPD and label it.

I. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

J. Provide primary power for each panel from normal/ emergency panels as indicated on the Electrical Power Plans. Power shall be 120V AC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices.

3.03 BOXES, ENCLOSURES AND WIRING DEVICES

A. All fire detection and alarm system devices, control units and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

B. Fire Alarm: Terminal cabinets shall be provided in locations shown and as otherwise required to support wiring terminations, troubleshooting and future tenant fit-up. Cabinets shall be painted red and contain terminal blocks to support the system wiring where the Control Panels are remote from the devices served. Cabinets shall include accommodation for all wiring including SLCs, notification circuits, and related addressable and fault isolation modules for future expansion and modification.

1. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.

C. Boxes shall be installed plumb and firmly in position.

D. Extension rings with blank covers shall be installed on junction boxes where required.

E. Junction boxes served by concealed conduit shall be flush mounted.

F. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

G. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers.

H. Panel enclosures shall be installed to meet clearance requirements per NFPA 70 and local codes. Minimum requirements shall be 3 foot clearance in front of the enclosure

3.04 CONDUCTORS

A. Each conductor shall be identified as shown on the shop drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.

B. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer. Utilize fire-rated red MC cable.

C. Wiring for strobe and audible circuits shall be a minimum 14 AWG, signal line circuits; 18 AWG twisted shielded, speaker circuits; 18 AWG twisted, telephone circuit; 18 AWG twisted shielded.

D. All splices shall be made using solder-less connectors. All connectors shall be installed in conformance with the manufacturer recommendations.

E. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

F. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

G. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

3.05 DEVICES

A. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.

B. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

C. All devices and appliances shall be mounted to or in an approved electrical box.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Permanently label or mark each conductor with alphanumeric wire markers at the main control panel, transponders, terminal cabinet and NAC booster panels.

C. A consistent color code for fire alarm system conductors throughout the installation.

3.07 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.

B. Testing General:

1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.

2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.

3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the schematic design drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.

4. Test reports shall be delivered to the acceptance inspector as completed.

5. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:

a. Ladders and scaffolds as required to access all installed equipment.

b. Multi-meter for reading voltage, current and resistance.

c. Two-way radios and flashlights.

d. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.

e. Decibel meter

f. Intelligibility meter

g. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the authority having jurisdiction.

3.08 ACCEPTANCE TESTING

A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

1. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.
2. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.

B. Preliminary Testing: Conduct preliminary tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

1. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.
2. Visually inspect wiring.
3. Test the battery charger and batteries.
4. Verify that software control and data files have been entered or programmed into the FACP.
5. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.
6. Measure voltage readings for circuits to ensure that voltage drop is not excessive.
7. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.
8. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. Test results recorded for use at the final acceptance test.
9. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the owner and test results recorded for use at the final acceptance test.
10. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.
11. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors shall comply with the requirements of NFPA 72 except that, for item 12(e) (Supervision) in Table 14.4.2.2, disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision shall be tested at each device.
12. All readings for Sound Pressure Level (SPL) and Intelligibility score shall be recorded on the installation drawings next to the speaker symbol. The readings shall then be added as propertied to each ADS on the "as-Built" drawings to be submitted at the conclusion of the Final Acceptance test.
13. Verify with all parties the required survivability of wiring, raceways, and junction boxes
14. Determine that the system is operable under trouble conditions as specified.

C. Final Acceptance Test: Notify the owner in writing when the system is ready for final acceptance testing. Submit request for test at least 30 calendar days prior to the test date. A final acceptance test will not be scheduled until the Preliminary Testing has been completed.

1. Provide documentation of Preliminary Testing results.
2. Test the system in accordance with the procedures outlined in NFPA 72 acceptance testing.
3. Demonstrate the performance of the required number and type of initiating devices and notification appliances per the AHJ's requirements.
4. The speakers and sound levels shall be tested to insure that the system meets the NFPA 72 intelligibility standards for Fire Alarm and Mass Notification Systems.
   a. The sound from the speakers shall be a minimum of 15dB above the ambient noise levels throughout the facility. Testing shall be done with a Sound Level Meter. Contractor shall record the ambient and alarm sound levels as part of the "System Certification Test Report".
   b. Verify intelligibility of the speakers throughout the facility to insure that the intelligibility meets the requirements. The test shall be performed with an Audio Intelligibility Analyzer such as a Goldline DSP-30B or the Quest Technologies Sound Pro SE/DL. The sound levels shall be tested at ear level throughout the facility and the results included in the "System Certification Test Report". The minimum Intelligibility score shall be a .8 CIS (Common Intelligibility Score) or .7 STI (Speech Transmission Index). The mean value of at least three readings shall be used to compute the intelligibility score at each test location. In high ambient noise areas or in areas where it is deemed impractical to meet the intelligibility levels, the AHJ has the authority to waive the testing in this area. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than 0.8 if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 ft to a location with a CIS score of at least 0.8.
5. Verify that Shop Drawings reflecting as-built conditions are accurate. Upon final approval by all parties, provide two sets of AS-built documents in a cabinet adjacent to the main FACP or designated area within the building. Per NFPA 72 7.7.2Measure the current in Notification appliance circuits under full load to assure that there is the calculated spare capacity for every circuit.

D. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
   1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      a. Open, shorted and grounded signal line circuits.
      b. Open, shorted and grounded notification, releasing circuits.
      c. Primary power or battery disconnected.
   2. System notification appliances shall be demonstrated as follows:
      a. All alarm notification appliances actuate as programmed
      b. Audibility and visibility at required levels.
      c. VOICE Intelligibility measurements at the time of commissioning.
   3. System indications shall be demonstrated as follows:
      a. Correct message display for each alarm input at the control display.
      b. Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.

c. Correct history logging for all system activity.

4. System off-site reporting functions shall be demonstrated as follows:
   a. Correct zone transmitted for each alarm input
   b. Trouble signals received for disconnect
5. Secondary power capabilities shall be demonstrated as follows:
   a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
   b. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
   c. System battery voltages and charging currents shall be checked at the fire alarm control panel.

3.09 DOCUMENTATION

A. System documentation shall be furnished to the owner and shall include but not be limited to the following:

1. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM or memory stick (thumb drive) with digital copies of the record drawings in PDF format.
2. System operation, installation and maintenance manuals.
3. System matrix showing interaction of all input signals with output commands.
4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
5. System program showing system functions, controls and labeling of equipment and devices.

3.010 PROTECTION

A. Remove and replace devices and panel components that are wet, moisture damaged, or mold damaged.

3.011 DEMONSTRATION

A. Include in the project the services of a factory-trained instructor, regarding the system operations, inspection requirements, and maintenance of the system provided. The instructor shall train the employees designated by the owner, in the care, adjustment, and operation of the fire alarm system.

1. Required Instruction Time: Provide 2 hours of instruction after final acceptance of the system. The instruction shall be given during working hours on such dates and times as are selected by the owner. The instruction may be divided into two periods and videotaped at the discretion of the owner.

B. Provide a printed instruction card in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory and trouble.

END OF SECTION 283100

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, removing site utilities and, abandoning site utilities in place.
7. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site or project job trailer if available.

1.5 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain, cleared materials shall become Contractor's property and shall be removed from Project site. Refer to Section 011100 Summary for additional information.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

D. Burning: No burning of materials is permitted on the project site.

1.7 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the architect and WCASD and authorities having jurisdiction.

B. Utility Locator Service: Notify PA OneCall for all public thoroughfares adjacent to the site.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

D. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in the Erosion and Sedimentation Control Plans, Notes and Details.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction according to erosion- and sedimentation-control Drawings until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal once approved by the Conservation District, Architect and the WCASD.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in the Erosion and Sedimentation Control Plans, Notes and Details.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations.

3.4 EXISTING UTILITIES

A. Contractor will coordinate for disconnecting and sealing of indicated utilities that serve existing structures before site clearing.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. The Contractor shall contact and coordinate with local jurisdictions for modifications of public utilities.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Request from utility companies and the WCASD a minimum of five (5) days notice before excavation or demolition the steps to take to avoid any damage.
2. Provide a minimum of five (5) days written notice to the WCASD for any utility shutdowns/interruptions. All notifications must be coordinated with the WCASD representative.
3. Do not proceed with utility interruptions without WCASD's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 2 inches (50 mm) in diameter, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches (150 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 1 inches (25 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off WCASD's property.

B. No burning of any kind is permitted on the WCASD’s property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for walks, pavements, turf and grasses and plants.
3. Excavating and backfilling for buildings and structures.
4. Subbase course for concrete walks.
5. Subbase course and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Design Professional. Authorized additional excavation and replacement material are to be paid by change order process only; field

modification of excavation must be confirmed by the WCASD representatives prior to performing work.

2. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Design Professional. Unauthorized excavation, as well as remedial work directed by Design Professional, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D 1586.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Meetings: Conduct preconstruction meeting at the Project site in project job trailer.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
   a. Personnel and equipment needed to make progress and avoid delays.
   b. Coordination of Work with utility locator service.
   c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
   d. Extent of trenching by hand or with air spade.
   e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.

2. Controlled low-strength material, including design mixture.

3. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches (300 by 300 mm).

2. Warning Tape: 12 inches (300 mm) long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the architect and WCASD and authorities having jurisdiction.

B. Utility Locator Service: Notify PA OneCall for all public thoroughfares adjacent to the site.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

D. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of washed stone or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and zero to 5 percent passing a No. 4 (4.75-mm) sieve.

J. Sand: ASTM C 33/C 33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: As follows:
   a. Grab Tensile Strength: ≥120 lbf; ASTM D 4632.
   b. Mullen Burst Strength: ≥225 psi; ASTM D 3786.
   c. Flow Rate: ≥95 gal./min./ft.^{2}; ASTM D 4491.
   d. UV Resistance after 500 hours ≥70%, ASTM D4355
   e. Heat set or heat calendared fabrics are not permitted.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.

2. Survivability: As follows:
   a. Grab Tensile Strength: 247 lbf (1100 N); ASTM D 4632.
   b. Sewn Seam Strength: 222 lbf (990 N); ASTM D 4632.
   c. Tear Strength: 90 lbf (400 N); ASTM D 4533.
   d. Puncture Strength: 90 lbf (400 N); ASTM D 4833.

3. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.

4. Permittivity: 0.02 per second, minimum; ASTM D 4491.

5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.

2. Yellow: Gas, oil, steam, and dangerous materials.

3. Orange: Telephone and other communications.

4. Blue: Water systems.

5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Install stone subbase under walks and pavements as indicated in details using PennDOT No 2A aggregate.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: As indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.

3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.

4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 6 inches (150 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

3.6 SUBGRADE INSPECTION

A. Notify Design Professional when excavations have reached required subgrade.

B. If Design Professional determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Design Professional, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Design Professional, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by the Design Professional.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the Design Professional.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Surveying locations of underground utilities for Record Documents.

3. Testing and inspecting underground utilities.

4. Removing concrete formwork.

5. Removing trash and debris.

6. Removing temporary shoring, bracing, and sheeting.

7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Install utility bedding as indicated on drawings or as per individual utility company's minimum pipe bedding requirements.

E. Warning Tape: Install warning tape directly above utilities, 8 inches (200 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.11 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.

2. Under walks and pavements, use satisfactory soil material.

3. Under steps and ramps, use satisfactory soil material.

4. Under building slabs, use satisfactory soil material.

5. Under footings and foundations, use satisfactory soil material.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 98 percent.

2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 95 > percent.

3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.

4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).

2. Walks: Plus or minus 1 inch (25 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

D. Proof Rolling for concrete and macadam walkways:

1. Proof Roll prepared base material surface to check for unstable areas. Begin paving work only after unsuitable areas have been corrected and are ready to receive paving.

E. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.

2. Shape subbase course and base course to required crown elevations and cross-slope grades.

3. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.

4. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Special Inspections: The Contractor will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.

2. Determine that fill material classification and maximum lift thickness comply with requirements.

3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. The Contractor shall maintain clear and orderly records of testing and procedures and make them available for field review and approval of the WCASD and its consultants.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length but no fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by the Design Professional; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off the WCASD’s property.

B. Transport surplus satisfactory soil to designated storage areas on the WCASD’s property. Stockpile or spread soil as directed by the Design Professional.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off the WCASD’s property.

END OF SECTION 312000

SECTION 312316.13 - TRENCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 RELATED REQUIREMENTS

1.3 DEFINITIONS

1.4 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010.

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

1.5 SUBMITTALS

A. Compaction Density Test Reports.

1.6 DELIVERY, STORAGE, AND HANDLING

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 PREPARATION

3.3 TRENCHING

A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove excavated material that is unsuitable for re-use from site.

G. Remove excess excavated material from site.

3.4 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.5 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Fill up to subgrade elevations unless otherwise indicated.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.

H. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

I. Correct areas that are over-excavated.
   1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

J. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
   2. At other locations: 95 percent of maximum dry density.

K. Reshape and re-compact fills subjected to vehicular traffic.

3.6 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

B. Utility Piping, Conduits, and Duct Bank

3.7 TOLERANCES

3.8 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

D. Frequency of Tests: As determined by geotechnical engineer.

END OF SECTION 312316.13

SECTION 313200 – SOIL STABILIZATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Final grading of Project Area to facilitate runoff to existing and proposed storm water catch basins. Modification to storm water catch basins in the Project Area may be required.

B. Seeding and maintenance of Project Area until grass is established.

C. All surfaces, pavements, parking lots, sidewalks, fencing, curbs, gutters, culverts and other features disturbed, damaged or destroyed during the performance of the Work that were not identified for deconstruction, shall be restored.

D. Demobilization activities including:

1. Timely removal of equipment, materials, supplies, and personnel from the Property.
2. Cleaning of all Project-related equipment and materials used for this Project.
3. Cleaning of the Project Area and Property for the duration of the Project to remove debris, waste, and other materials associated with the Project.
4. Removal of temporary fencing surrounding the Work Area.

E. Coordination with all other Work associated with the Project in accordance with the Contract Documents.

F. Compliance with all Laws, EHS Laws, and all applicable state regulations, local ordinances, and other requirements.

1.3 ACTION SUBMITTALS

1.4 INFORMATIONAL SUBMITTALS

A. Project Execution Plan shall be submitted for review.

1.5 SCHEDULE OF RESTORATION

A. A schedule of restoration operations shall be submitted for review. After an accepted schedule has been agreed upon it shall be adhered to unless otherwise revised with the approval from the WCASD.

1.6 EXISTING CONDITIONS

A. Contractor shall be responsible for protecting all storm sewer features, existing structures, pavements, and other surfaces where these features are designated to remain.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The quality of materials and the performance of Work used in the restoration shall produce a surface or feature acceptable to the WCASD and in compliance with generally accepted construction methods.

B. Temporary and permanent soil stabilization shall follow PaDEP guidelines and the approved mixes and application rates for seed, fertilizer, liming and mulch as indicated in the Erosion Control details and note sheet.

PART 3 - EXECUTION

3.1 FINAL GRADING AND STORM WATER RUNOFF

A. If seeding of the Project Area is not possible due to seasonal constraints, the project area shall be stabilized by the Contractor with straw or other approved stabilization method(s) until such time as weather is suitable for seeding. During this time, the Contractor shall maintain required erosion control measures and make required storm water inspections. Erosion issues identified during this period shall be promptly remedied by the Contractor.

B. Prior to seeding, the Contractor shall conduct final grading of the Project Area so that the final grade is consistent with the Grading Plan and that storm water flows to the existing and proposed storm water catch basins. The Project Area shall be smooth, free of rocks, and blend in with the adjacent terrain.

C. If required, the Contractor shall modify existing catch basins to be compatible with the final grade which could include raising, lowering, moving, or abandoning existing catch basins.

3.2 SEEDING

A. The Contractor shall prepare and hydroseed the Project Area using the seed mix as noted on the plan or pre-approved by the WCASD.

B. The Contractor shall be responsible for conducting the maintenance required until seed is established. These maintenance items include, but are not limited to, watering, fertilizing, erosion management, re-grading, weed abatement, re-seeding, and mowing.

C. The first mowing of grass shall begin as soon as the grass is full and has reached a height of 3 inches and subsequent mowing shall be as often as necessary to maintain turf areas at a uniform height of 1-1/2 to 2 inches.

D. The establishment of grass shall be considered complete when there are no bare spots, limited weeds, and the grass has been mowed a minimum of 3 times, and the grass is at least 1-1/4 to 2 inches in height.

3.3 OTHER TYPES OF RESTORATION

A. Any items, surfaces, structures, etc. incidentally damaged as a result of the Project must be restored in like material and configuration to that which existed prior to the damage.

B. Contactor shall verify that final restored grass area has proper runoff that does not result in erosion, ponding, flooding or other unsatisfactory conditions. Contractor is responsible for remedying issues promptly and fully.

3.4 FINAL INSPECTION

A. Upon completion of all restoration activities, the Contractor shall conduct a final inspection with the architect and the WCASD representatives. The Contractor shall be responsible for correcting all deficiencies observed during the final inspection. Once the final inspection is approved, the Contractor may complete final demobilization from the Project Area.

3.5 FINAL INSPECTION

A. Upon completion of all restoration activities, the Contractor shall conduct a final inspection with the architect and the WCASD representatives. The Contractor shall be responsible for correcting all deficiencies observed during the final inspection. Once the final inspection is approved, the Contractor may complete final demobilization from the Project Area.

END OF SECTION 313200

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site or project job trailer if available.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system.
9. Review adjacent and existing structures and associated support and protection systems

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.

2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Land surveyor.
2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the state in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.6 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.7 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify the architect and the WCASD or its representative no fewer than five (5) days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without the architect and the WCASD or its representative’s written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads:

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

C. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

H. Tiebacks: Steel bars, ASTM A722/A722M.

I. Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.5 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks daily during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Design Professional if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
2. Remove excavation support and protection systems to a minimum depth of 48 (1200) inches (mm) below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt overlay.
3. Cold milling of existing asphalt pavement.
4. Hot-mix asphalt patching.

B. Related Requirements:

1. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site or at project trailer.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
   a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
   b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Herbicide.
2. Paving geotextile.
3. Joint sealant.

B. Hot-Mix Asphalt Designs:

1. Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the standard specifications of PADOT Publication 408 latest edition.

C. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

1. Paving Geotextile: 12 by 12 inches (300 by 300 mm) minimum.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paving-mix manufacturer.

B. Material Certificates: Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

1. Aggregates.
2. Asphalt binder.
3. Asphalt cement.
4. Cutback prime coat.
5. Emulsified asphalt prime coat.
6. Tack coat.
7. Fog seal.
8. Undersealing asphalt.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage an experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.

1. Firm shall be a registered and approved paving mix manufacturer with PADOT.

B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.

C. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicted for this Project and with a record of successful in-service performance.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
2. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).

3. Slurry Coat: Comply with weather limitations in ASTM D3910.
4. Asphalt Base Course and Binder Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D692/D692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D242/D242M, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. General: Use locally available materials and gradations which exhibit a satisfactory record of previous installations.

1. Bituminous Tack Coat: PADOT Designation E1, E6 or E8
2. Bituminous Binder Course: PADOT Designation 25mm Superpave
3. Bituminous Wearing Course: PADOT Designation 9.5mm Superpave
4. Aggregate Base Course: PADOT Type 2A aggregate.
5. Joint and crack filling and sealing: Emulsified Asphalt conforming to PADOT Publication 408, Section 469.2.

B. Water: Potable.

C. Undersealing Asphalt: ASTM D3141/D3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wettable powder form.

B. Pavement-Marking Paint: Latex, water-base emulsion, ready-mixed, complying with FS TT-P-1952.

1. Color: Blue. (handicapped striping only)
2. Color: White

2.4 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Pavement subgrades are to be compacted just prior to paving to a minimum 95 percent of the maximum dry density as determined by ASTM D1557.

2.5 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

2.6 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 1-1/2 inches (38 mm).
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, driveway aprons, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 1 inch (25 mm) after milling, before wearing course is laid.
7. Handle milled asphalt material in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."
8. Keep milled pavement surface free of loose material and dust.
9. Do not allow milled materials to accumulate on-site.

2.7 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Undersealing: Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Single-Course Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Two-Course Patch Material: Partially fill excavated pavements with hot-mix asphalt base course mix and, while still hot, compact. Cover asphalt base course with compacted layer of hot-mix asphalt surface course, finished flush with adjacent surfaces.

2.8 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm).

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

2.9 SURFACE PREPARATION

A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth (0.5 to 1.40 L/sq. m per 25 mm depth). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

2.10 INSTALLATION OF PAVING GEOTEXTILE

A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m).

B. Place paving geotextile promptly in accordance with manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches (100 mm) and transverse joints 6 inches (150 mm).

C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

2.11 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course and binder course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F (121 deg C).
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches (25 to 38 mm) from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course and binder course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

2.12 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

2.13 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density, Marshall Test Method: 96 percent of reference laboratory density in accordance with ASTM D6927, but not less than 94 percent or greater than 100 percent.
2. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

2.14 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Base Course and Binder Course: Plus or minus 1/2 inch (13 mm).
2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Base Course and Binder Course]: 1/4 inch (6 mm).

2. Surface Course: 1/8 inch (3 mm).
3. Retain "Crowned Surfaces" Subparagraph below if required.
4. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

C. Asphalt Traffic-Calming Devices: Compact and form asphalt to the shapes indicated and within a tolerance of plus or minus 1/8 inch (3 mm) of height indicated above pavement surface.

2.15 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness in accordance with ASTM D3910 and allow to cure.
1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

2.16 FIELD QUALITY CONTROL

A. Testing Agency: The WCASD will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with ASTM D979/D979M.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.
    a. One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

SECTION 321373 - ASPHALT PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hot-applied joint sealants.
2. Joint-sealant backer materials.
3. Primers.

1.3 PREINSTALLATION MEETINGS

A. Retain "Preinstallation Conference" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.

B. Preinstallation Meeting: Conduct preconstruction meeting at the Project site in project job trailer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Retain "Samples for Verification" Paragraph below if a color choice is available for joint-sealant types specified.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

B. Qualification Data: For Installer.

C. Retain "Product Certificates" Paragraph below to require submittal of product certificates from manufacturers.

D. Product Certificates: For each type of joint sealant and accessory.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving.

1. Joint Location:
    a. Joints between concrete and asphalt paving.
    b. Joints between concrete curbs and asphalt paving.
    c. Other joints as indicated.
2. Joint Sealant:Hot-applied, single-component joint sealant.
3. Joint-Sealant Color: Manufacturer's standard.

END OF SECTION 321373

SECTION 321600 CURBS AND SIDEWALKS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Preparation and placement of Portland cement concrete curb.
2. Preparation and placement of Portland cement concrete sidewalk.
3. Preparation and placement of combination Portland cement concrete curb and gutter.

1.3 REFERENCE STANDARDS

A. American Concrete Institute (ACI) latest edition

1. 304R Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete
2. 308 Standard Practice for Curing Concrete

B. American Society for Testing and Materials (ASTM) latest edition

1. A 615 Deformed and Plain Billet-Steel for Concrete Reinforcement
2. C 33 Concrete Aggregates
3. C 94 Ready-Mixed Concrete
4. C 150 Portland Cement
5. C 260 Air-Entraining Admixtures for Concrete
6. C 309 Liquid Membrane-Forming Compounds for Curing Concrete
7. C 494 Chemical Admixtures for Concrete
8. D 1751 Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

C. Federal Specifications

1. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces

1.4 QUALITY ASSURANCE

A. Establish and maintain required lines and elevations.

B. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by the WCASD.

1.5 SUBMITTALS

A. Submit materials certificate to the independent testing laboratory which is signed by materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein.

1.6 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Forms shall be of depth equal to depth of curbing or sidewalk, and so designed as to permit secure fastening together at tops. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.

B. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.

C. Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D 1751, FS HH-F-341, Type II, Class A.

D. Joint Sealers: Non-priming, pourable, self-leveling polyurethane. Acceptable sealants are Sonneborn "Sonolastic Paving Joint Sealant" Sonneborn "Sonomeric CT 1 Sealant", Sonneborn "Sonomeric CT 2 Sealant", Mameco "Vulken 245", or Woodmont Products "Chem-Caulk".

2.2 MIX DESIGN AND TESTING

A. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following:

1. Compressive Strength: 4,000 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings.
2. Slump Range: 2 to 5-inches at time of placement
3. Air Entrainment: 5 to 8 percent

PART 3 - EXECUTION

3.1 PREPARATION

A. Proofroll prepared base material surface to check for unstable areas. Begin paving work only after unsuitable areas have been corrected and are ready to receive paving.

B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

A. Form Construction

1. Set forms to required grades and lines, rigidly braced and secured.
2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
3. Check completed formwork for grade and alignment to following tolerances:
   a. Top of forms not more than 1/8-inch in 10'-0"
   b. Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0"
4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.

B. Concrete Placement

1. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until set at required finish elevation and alignment.
2. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
3. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint. Automatic machine may be used for curb and gutter placement. Machine placement shall be at required cross section, line, grade, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified herein.

C. Joint Construction

1. Contraction Joints: Construct concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, in uniform sections of length specified on Construction Drawings. Form joints between sections either by steel templates, 1/8-inch in thickness, of length equal to width of curb and gutter, and with depth which will penetrate at least 2-inches below surface of curb and gutter; or with 3/4-inch thick performed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 2-inches while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold it's shape, but shall be removed while forms are still in place.

2. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on Construction Drawings.
3. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement.

D. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.

E. Joint Sealants: Seal joints with approved exterior pavement joint sealants. Install in accordance with manufacturer's recommendations.

3.3 CONCRETE FINISHING

A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.

B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:

1. Curbs, gutters, and sidewalks: Broom finish by drawing fine-hair broom across surface perpendicular to flow of traffic. Repeat operation as necessary to produce fine line texture.

C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed Owner.

D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in "water-curing" section of ACI 308.

3.4 BACKFILL

A. After concrete has set sufficiently, spaces on either side of concrete curb, combination concrete curb and gutter, or concrete sidewalk shall be refilled to required elevation with suitable material compacted in accordance with Section 312000 “Earth Moving.”

3.5 CLEANING AND ADJUSTING

A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION 321600

SECTION 329100 - PLANTING SOILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes Planting Soils including the following:

1. Assessing salvaged stockpiled topsoil for use in planting mixes and backfills.
2. Separating salvaged topsoil that is found suitable for use and determining topsoil quantity.
3. Furnishing approved topsoil from outside sources should existing salvaged topsoil not be of sufficient quantity to complete the project.
4. Providing soils tests and data for evaluation and approvals of the soil mixes, topsoil, sand and organic materials.
5. Restoring compacted soils and preparing existing subgrade to receive planting mixes.
6. Restoring lawn areas that are disturbed or damaged by the work.

B. Related Sections:

1. Section 329300 “Plants”

C. References:

1. ASTM C136/C136M: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
2. ASTM C33/C33M: Standard Specification for Concrete Aggregates
3. ASTM C 602: Agricultural Liming Materials
4. ASTM D2974: Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

1.3 SUBMITTALS

A. Product Data: Submit manufacturer product data and literature describing all products required by this section to the Landscape Architect for approval.

B. Samples: Submit samples of each product and material where required by the specification to the Engineer for approval. Label samples to indicate product, specification number, characteristics, and locations in the Work. Delivered materials shall closely match the samples.

1. Submit one-gallon samples of all topsoil (salvaged and imported), coarse sand, and organics and one-gallon samples of planting mixes, and soil additive products in this section. The number of samples shall be as required for each material.

a. Samples should be labeled to include the location of the source of the material.
b. Samples of all topsoil, drainage fill, coarse sand, and planting mixes shall be submitted at the same time as the particle size and physical analysis of that material.
c. Planting mixes shall be labeled as to the percentage of each component in the mix.
d. Samples of all products and planting mix components shall be submitted twelve weeks before the installation of planting mixes. Planting mixes shall be submitted within two weeks following approval of the mix component.

2. Submit soil test analysis report for each sample of topsoil and planting mix from an approved soil-testing laboratory below.
   a. Provide a particle size analysis,
   b. Provide a chemical analysis including the following:
      1) pH and Buffer pH.
      2) Percent organic content by oven dried weight.
      3) Nutrient levels by parts per million including nitrogen, phosphorus, potassium magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the planting mix for the plant material specified.
      4) Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
      5) Cation Exchange Capacity (CEC).
   c. All testing will be at the expense of the Contractor.

1.4 SEQUENCING AND SCHEDULING

A. General: Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades. Schedule shall include sampling and laboratory turnaround time, including time for re-submittals if required to satisfy requirements of the specifications

B. Schedule the installation of planting mixes after the area is no longer required for use by other trades and work.

C. Schedule all utility installations prior to beginning work in this section.

1.5 QUALITY ASSURANCE

A. Contractor is solely responsible for quality control of the Work.

B. The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the Work, including the preparation, mixing and installation of custom planting mixes.

C. Comply with applicable requirements of the laws, codes, ordinances and regulations of federal, State and municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect soil and planting mix stockpiles from rain and washing that can separate fines and coarse material. Cover stockpiles with filter cloth at the end of each workday.

B. Protect planting mix stockpiles from contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage.

1.7 PROJECT CONDITIONS

A. Weather: Do not mix, deliver or place soils in frozen, wet, or muddy conditions.

B. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to report any circumstances that will negatively impact soil drainage. Do not proceed with work until unsatisfactory conditions have been corrected.

1.8 PROTECTION OF EXISTING UTILITIES

A. Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked.

B. Carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

PART 2 - PRODUCTS

2.1 SALVAGED STOCKPILED TOPSOIL

A. Acceptable friable loamy soil that is reasonably free of subsoil, clay, brush, roots, weeds, other objectionable vegetation, stones, or other foreign material larger than 1 inches in any dimension, litter, and/or other material unsuitable or harmful to the growing of vegetation.

B. If conditions permit contractor shall remove and salvage as much Brown to grey/brown loam to clay loam organic soil prior to the start of construction and stockpiled at the site.

C. Soils encountered that contain quantities of orange/brown to orange clay soil shall be discarded and not used.

D. Quantities of usable material are not confirmed. The Contractor shall confirm the quantities of existing soil available at the site.

2.2 IMPORTED TOPSOIL

A. Shall have the same criteria as outlined above for Salvaged and Stockpiled Topsoil containing not less than 2.0% or more than 10% percent by weight organic matter. The soils obtained shall be obtained from a site where the soil quality has proven ability to grow crops. The pH value shall be between 6.0 and 7.0.

1. The Contractor is responsible for the reconditioning of the area from which the topsoil is obtained, and in accordance with all Local, State, and Federal regulations.
2. The contractor shall supply necessary documentation verifying that topsoil is free of contamination.

B. Soil Texture: Loam to Coarse Sandy loam with clay content between 15 and 20% and sand content between 45 and 60%.

C. Soil shall be lighting screened and shredded prior to mixing but shall retain some of the original soil structure with ped sizes (clods) not greater than 1" diameter.

D. Provide a minimum of 3 soil tests that represents the range of the soil types available at any one-source location.

E. Provide 1-gallon samples from each topsoil source with soil testing results. The sample shall be a mixture of the multiple samples taken throughout the source stockpile or field.

2.3 COARSE SAND

A. Coarse concrete sand, ASTM C33/C33M Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.

1. Coarse Sands shall be clean, sharp, natural sands free of limestone, shale and slate particles. Coarse Sand pH shall be lower than 7.0.
2. Provide the following particle size distribution (ASTM C136/C136M):

ASTM Sieve Size (mm)	Percentage passing by weight
3/8 in. (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	80 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (600 mm)	25 to 60
No. 50 (300 mm)	10 to 30
No. 100 (150 mm)	2 to 10

B. Provide 1-gallon sample with manufacturer's literature and material certification that the product meets the requirements.

2.4 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80% calcium carbonate equivalent and as follows:

1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75% passing through No. 60 (0.25-mm) sieve.
2. Class: Class O, with a minimum 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55% passing through No. 60 (0.25-mm) sieve.
3. Provide Lime in the form of dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90% sulfur with a minimum 99% passing through No. 6 (3.35-mm) sieve and a minimum of 10% passing through No. 40 (0.425-mm) sieve.

C. Iron sulfate: Granulated ferrous sulfate containing a minimum of 20% iron and 10% sulfur.

D. Aluminum Sulfate: Commercial Grade, unadulterated.

E. Agricultural Gypsum: Finely ground, containing a minimum of 90% calcium sulfate.

F. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption.

2.5 ORGANIC MATTER

A. Organic blended material composted sufficiently to break down all woody fibers, seeds and leaf structures, free of toxic and non-organic matter. Source material shall be limited to the following:

1. Aerobically composted yard debris. Note compost made from primarily green yard waste shall not be acceptable.
2. Hardwood bark fines and organic material designed to produce compost high in fungal material.
3. Biosolids compost, or combination of the above.
4. Organic Matter shall be commercially prepared compost and meet US Compost Council STA/TMECC criteria for stable, mature product.
5. Submit one-pound sample and supplier’s literature certifying STA compliance for approval.

B. Compost shall be a homogeneous material free of soil clods, lumps, roots, stones, and foreign material. The compost shall be screened such that a minimum of 90% passes US standard 0.25” sieve and no more than 20% passes a US Std. No. 10 sieve.

1. Provide a one-gallon sample with manufacturer’s literature and material certification that the product meets the following requirements:
   a. pH of 5.5 to 6.5.
   b. Soluble Salts: less than 6.0 milliohms per cm when determined on saturation extract.
   c. Organic Matter Content: 35% or greater, as determined by weight by ASTM D2974-87 Method C.
   d. Carbon Nitrogen Ratio: less than 36:1
2. All compost testing shall be done in conformance with the U.S. Compost Council's publication Test Methods for the Examination of Composting and Compost unless specified otherwise.

C. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.6 CHEMICAL ADDITIVES

A. Chemical materials designed to increase soil fertility. All material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the season in which the products are to be used.

1. Fertilizer for planting shall be organic fertilizer, derived from organic sources. Fertilizer selections shall be based on the recommendations of the soil tests. Submit manufacturers' product literature for approval.

2.7 GENERAL PLANTING AND LAWN MIX

A. General planting mix shall be of 100% approved imported topsoil.

B. DO NOT overly mix or screen soil. Planting mix should contain individual soil peds (clods) averaging between 1-2 inches in diameter from the original soil structure. No clods are to be larger than 2 inches in diameter in any direction.

C. Adjust the final mix pH to 6.0-7.0.

D. Provide a one-gallon sample with soil test results.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Protect of Existing Vegetation: All existing vegetation to remain shall be protected at all times in accordance with the Drawings.

B. Examine the grades and soil conditions for any circumstances that might be detrimental to soil drainage, including but not limited to: uneven subgrades and waterproofing that may hold or pond water; deposits of construction-related sediment, waste or soil contamination; storage of material or equipment; soil compaction or poor drainage. Confirm that all utility work and installation of planter or on structure drainage has been completed and tested. Examine the grading verifying all elevations. Confirm that all other work in the area of planting mix installation is completed. Confirm that subgrade conditions present positive flow to outfall or building edge conditions such that all planting areas will have positive subsurface drainage.

C. Notify the Landscape Architect in writing of any unsatisfactory conditions.

3.2 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work of this section. Do not place soils or mixes in any locations if they will be adversely compacted or disturbed from other trades work. Coordinate with the General Contractor to protect installed soils and planting mix from compaction by other trades.

B. Provide sediment control to retain planting mixes within the project limits as needed.

3.3 PROTECTION OF EXISTING FEATURES

A. Do not excavate beds in areas that may damage existing tree roots of mature trees.

B. Protect adjacent walls, walks and utilities from damage or staining by the soil or placement operations. Use 1/2-inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items, and as directed by the Landscape Architect during the progress of the work.

1. Clean up any soil or dirt spilled on any paved surface, including at the end of each working day.
2. The Contractor shall repair damages to the paving or architectural finishes to the satisfaction of the Landscape Architect and/or Owner.

3.4 GENERAL SOILS INSTALLATION

A. Begin installing approved soils and planting mixes by backfilling the beds and planting areas with the first lift by tilling or blending with existing loosened subgrade. Note soil peds in the 1- 2-inch range is acceptable and often aid in soil adhesion and drainage.

B. Soils and planting mixes shall be spread with approved equipment to a minimum depth of 6 inches to permit a 1-inch settlement. Place soils in 6-inch lifts compacting lightly to not more than 80-85% at the depths and elevations shown on the drawings.

C. Any surface irregularities shall be corrected to prevent the formation of low spots and pockets that would retain water.

D. Soils and planting mixes shall not be placed when the subgrade is frozen, excessively wet, or extremely dry, and no soils shall be handled when in a frozen or muddy condition.

E. Protect the tilled area from traffic until the planting mix is installed. DO NOT allow the sub grade to become compacted. In the event that the roughened area becomes compacted, loosen the area again prior to installing the planting mix.

3.5 APPLICATION OF ORGANICS AND CHEMICAL ADDITIVES

A. Contractor shall add up to 15% organic material in the top 24” of backfilled soils in planting beds.

B. Do not use fertilizers unless recommended by soils tests.

C. Following the installation of each planting mix, apply chemical additives in rates as recommended by the soil tests, and appropriate to the planting mix and specific plants to be installed.

D. Types, application rates and methods of application shall be approved by the Landscape Architect prior to any applications.

E. Approximately one month after any application of chemical additives, re sample and test the soil and apply additional applications if the soil tests indicate further chemical applications would be beneficial. Make sufficient tests to analyze each soil type and each plant association within that soil type.

3.6 PLANTING MIX PROTECTION

A. Protect planting mix from compaction and contamination by dust, debris, and any toxic material harmful to plants or humans after placement. Any area, which becomes compacted, shall be tilled to a depth of 6". Any uneven or settled areas shall be filled and re graded.

B. Phase the installation of the planting mix such that equipment does not have to travel over already installed planting mix.

3.7 CLEAN-UP

A. During installation, keep pavements clean and work area in an orderly condition.

B. Keep the site free of trash and debris at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.

C. All trash shall be kept in a central collection container. Do not bury trash or debris in back-fill.

D. Once installation is complete, remove any excess soil from pavements, walls or other surfaces.

3.8 PROTECTION DURING CONSTRUCTION

A. The Contractor shall protect soil work and materials from damage due to landscape operations, operations by other Contractors or trespassers. Install 1/2-inch plywood mats over the soil wherever vehicles, equipment or foot traffic must enter the area Maintain protection during installation until acceptance. Treat, repair or replace damaged planting mix installation work immediately.

B. Till compacted planting mix and replace planting mix that has become contaminated as determined by the Landscape Architect. Planting mix shall be tilled or replaced by the Contractor at no expense to the Owner.

END OF SECTION 329100

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Erosion-control materials.

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture. Include identification of source and name and telephone number of suppliers.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawn Care Manager.
    c. Landscape Industry Certified Lawn Care Technician.
5. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: March 15 to June 1.
2. Fall Planting: August 1 to October 15.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
2. Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
3. Provide mixes comprised of seed species in proportions as indicated on Drawings.

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:
   a. 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition:
   a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
   b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

E. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

A. Retain applicable paragraphs in this article; revise to suit Project or insert other erosion-control materials.

B. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples.

C. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples.

D. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, as noted on drawings. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at rates indicated on Drawings

C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

E. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre (5.2-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre (10.4 kg/92.9 sq. m).

3.6 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, re

grade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow to a height of 1-1/2 to 2 inches (38 to 50 mm).

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

3.7 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.8 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations.

Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.9 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.10 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 60 days from date of planting completion.
    a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Meadow Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than maintenance period below.

1. Maintenance Period: 60 days from date of planting completion.

END OF SECTION 329200

SECTION 329300 – PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Tree stabilization.
3. Tree-watering devices.

B. Related Requirements:

1. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

D. Finish Grade: Elevation of finished surface of planting soil.

E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

G. Planting Area: Areas to be planted.

H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Three years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Interior.
    c. Landscape Industry Certified Horticultural Technician.
5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject

unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.

4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Deciduous trees and shrubs: October 15 to November 30 and April 1 to May 15.
2. Evergreen trees: March 1 to May 15 and August 1 to September 15.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   b. Structural failures including plantings falling or blowing over.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.
   a. Trees, Shrubs and Ornamental Grasses: 12 months.
   b. Ground Covers, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 21-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.

2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
3. Color: Natural.

2.4 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes.
3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

2.6 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

B. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Backfill: Planting soil. For trees, use excavated soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
    a. Quantity: According to manufacturer’s published data sheets, for each type and size of plant.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Backfill: Planting soil.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
   a. Quantity: According to manufacturer's published data sheets, for each type and size of plant.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:
   a. Stake trees of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend to the dimension indicated on Drawings. Set vertical stakes and space to avoid penetrating root balls or root masses.
   b. Stake trees with two stakes for trees up to 12 feet (3.6 m) high and 2-1/2 inches (63 mm) or less in caliper; three stakes for trees less than 14 feet (4.2 m) high and up to 4 inches (100 mm) in caliper. Space stakes equally around trees.

2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch (75-mm) average thickness, with 36-inch (900-mm) radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch (75-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.10 INSTALLATION OF EDGING

A. Shovel-Cut Edging: Separate mulched areas from turf areas[, curbs, and paving] with a 45-degree, 4- to 6-inch- (100- to 150-mm-) deep, shovel-cut edge[as indicated on Drawings].

3.11 INSTALLATION OF SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.12 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.13 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.14 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

3.15 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.16 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Three months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Three months from date of Substantial Completion.

END OF SECTION 329300

SECTION 331000 - WATER UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes water-distribution piping and related components for water service mains.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with Aqua Pennsylvania Specification and Standard Details.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for main piping.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Pipes and Fittings.
2. Valves and accessories.

B. Coordination Drawings:

1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from water system piping. Indicate interface and spatial relationship between piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. At project closeout, submit record drawings of installed water piping and products, in accordance with requirements of Division 01.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by WCASD or others unless permitted by Aqua Pennsylvania and under the following conditions, and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify WCASD not less than five (5) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without WCASD's written permission.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. All pipe and fittings shall be bituminous coated ductile iron conforming to ANSI specification A 21.51 (C-151), 18 feet nominal length, cement lined B THK A 21.4 AWWA (C-104) (BCL &SC) CTD OD, Tyton joint A 21.11 complete, Class 52.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping shall be the following:

1. Ductile-iron, Class 52 cement-lined, Tyton joint.

3.4 MECHANICAL JOINT RESTRAINT SYSTEMS

A. In addition to concrete reaction backings, all mechanical joint ductile iron fittings shall require restrained joint systems and shall be installed according to the manufacturer's standard recommendations. EBAA Iron 1100 series or Ford 1400 series restrained systems shall be used.

3.5 PIPING INSTALLATION

A. Service Installations and Accessories: Water service shall be installed with resilient seat gate valve or tapping sleeve and resilient seat tapping valve. The service line will be class 52 cement lined ductile iron pipe and shall be run perpendicular to the road and/or the water main. The joint out of the valve must have a retaining ring, and if any other joints or fittings are necessary they must be restrained with "Locktite" (or equal) gaskets for push-on joints or retaining rings for mechanical joints. All fittings must be mechanical joint and must be blocked to the same Aqua Pennsylvania specifications as required for water main installation.

B. Warning Tape: Install warning tape with metal strip directly above utilities, 8 inches below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.6 ANCHOR INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types shall be arranged with Aqua Pennsylvania according to the requirements.:

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.10 CONNECTIONS

A. Connect water-service piping to existing water main according to Aqua Pennsylvania instructions.

3.11 FIELD QUALITY CONTROL

A. Water Main Testing: Pressure Test and Leakage Test in accordance with Aqua Pennsylvania Specifications.

B. Prepare reports of testing activities and furnish to the Design Professional.

3.12 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. See Section 312000 "Earth Moving" for underground warning tapes.

END OF SECTION 331000

SECTION 333000 - SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This work shall consist of the construction of sanitary sewer gravity, sanitary sewer connections, miscellaneous fittings, and testing at designated locations, to the prescribed lines, grades, and dimensions.

1.3 QUALITY ASSURANCE

A. Comply with applicable portions of National Standard Plumbing Code, West Whiteland Township and other applicable codes pertaining to selection and installation of sanitary sewage system materials and products.

B. Conform to applicable requirements of the West Whiteland Township Public Works Department Rules for Making Connections to the West Whiteland Township Sewers.

1.4 REQUIREMENTS, TESTS AND INSPECTION

A. All materials shall be tested for conformance to the current specifications, and in accordance with the current standard test methods, of technical societies, institutes, associations of Federal and State specifications, as called for in these specifications, in the Special Specifications of the Contract or as called for by the Design Professional. Current specifications and current standard test methods are defined as the latest editions, amendments of revisions that are current at the time of receipt of bids.

B. The West Whiteland Township Public Works Department will inspect the tap connection of new sewer laterals to West Whiteland Township.

C. Manufacturer's Qualifications: All materials shall be obtained from firms regularly engaged in manufacture of sewer system products of types, materials, and sizes required, whose products have been in satisfactory use of similar service for not less than 5 years.

D. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with sanitary sewage work similar to that required for project.

E. Codes and Standards - Plumbing Code Compliance: Comply with applicable portion of West Whiteland Township Standard Plumbing Code pertaining to selection and installation of sewage system's materials and products.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for sanitary sewage materials and products.

B. Record Drawings: At project closeout, submit record drawings of installed sewage piping and products, in accordance with requirements of Division 01.

C. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

PART 2 - PRODUCTS

2.1 PIPES AND PIPE FITTINGS

A. General: Comply with applicable portion of the West Whiteland Township Standard Plumbing Code pertaining to selection and installation of sanitary sewer materials and products.

2.2 POLYVINYL CHLORIDE GRAVITY SEWER PIPE AND FITTINGS

A. General: Each pipe and fitting: Mark with manufacturer's name or trademark, specification designation, pipe class and strength, production shift code, and manufacture date and location.

B. Pipe and Fittings: ASTM D3034, wall thickness classification SDR26, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM D3212, elastomeric seals for gasketed joints conforming to ASTM F-477. Pipe shall be factory tested and conform to ASTM D-2444 (impact resistance) and conform to ASTM D-2444 (impact resistance) and ASTM D-2152 (extrusion quality).

C. Manufacturer of the PVC pipe shall be one of the following; JM Manufacturing Co.; or Ipex.

2.3 CONNECTIONS

A. Coupling/Adapters: For gravity sewer connections between different types of pipe and point repairs, approved manufacturers are as follows:

1. FERNCO Joint Sealer Co. with shear ring.
2. DFW by NDS non-shear.

B. Flexible Gasket Connectors (ASTM C923) for connecting pipes to sewer manholes:

1. Approved manufacturers for connectors connecting with diameter dimension of polyvinyl chloride (PVC) ASTM D3034, and PVC ASTM F679 to sewer manholes:
   a. A-LOK Products Inc., A-LOK or A-LOK X-CEL.

b. Press Seal Gasket Corporation, Press Boot, PSX Series, Econoseal, or equal.
c. NPC Incorporated, KOR-N-SEAL I Toggle Korband with Series 106 or 406 rubber boot.

C. Transition Gasket to connect DIP to PVC Pipe, Approved manufacturers:

1. Harrington Corporation.
2. Romac Industries.

2.4 BEDDING MATERIAL

A. Crushed Stone for Pipe Bedding: Crushed stone or pea gravel in accordance with the following requirement:

SIEVE SIZE	TOTAL PERCENT BY WEIGHT PASSING SIEVE
3/4 in.	100
1/2 in.	90-100
3/8 in.	40-70
No. 4	0-15
No. 8	0-5

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 310000 – “Earthwork”.

3.2 INSTALLATION OF PIPE AND PIPE FITTINGS

A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. Excavation shall not be started until the exact locations of utility structures have been determined in the field by the Contractor. Flow in existing sewage facilities shall be maintained during construction of the new sewers. The Contractor is responsible for bypass pumping and/or piping as is necessary to maintain flows.

C. Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

D. Lay piping beginning at the low point of the system, true to grades and alignment indicated, with unbroken continuity of invert.

E. Place bell ends and groove ends of piping facing upstream.

F. The width of trenches for sewers shall be as shown on the drawings.

G. Where trench openings for pipes remain open overnight within or adjacent to roadways or sidewalk open to traffic and pedestrians, they shall be adequately maintained and protected to the satisfaction of the Design Professional. Provide, install and operate a dewatering system when necessary to stabilize the trench. The dewatering system shall be removed upon completion of the backfill. Trenches shall not be open more than three hundred (300) feet in advance of the laid pipe within approval.

H. The manufacturer's recommendations for pipe assembly must be closely followed. Care must be taken to clean the mating surfaces of the joints before jointing. The jointing surfaces shall be lubricated as recommended by the manufacturer. The pipe ends shall be aligned and assembled by hand, bar or the use of a come-along. In all instances the ends of the pipe must be protected against damage.

I. Protection of Pipes: The mouth of the pipes, in the trenches, shall be carefully protected from rock falls or damage from any other source. In addition, the mouth of the pipes shall be provided with means to prevent earth or any other substance from entering.

J. Length of Pipes: All pipes used in the construction of sewers, and other connects shall be the maximum length produced, except where shorter lengths are required for closures, curved sewers or to secure proper locations for laterals.

K. Make changes in direction for waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Provisions of Lateral Connections:

1. Laterals shall be constructed to have a direct fall between the building and the connection at the sewer.

M. All pipe shall be placed on a stone or concrete cradle as shown on the plans. Pipe with less than 3 feet of cover shall be encased in concrete, minimum thickness 9 inches.

N. Connections: Laterals shall be connected to the Township's sewer pipe at existing wye branches. When an existing wye branch is not installed, the connection shall be made with factory manufactured wye branches.

O. Installing Pipe Fittings:

1. After the pipes are placed in the trench, they shall be prepared for coupling by thoroughly cleaning and then lubricating the joint. For pipes manufactured to accept "O" ring gaskets, the groove and the "O" ring gasket shall be lubricated as recommended by the manufacturer. The gasket shall be placed in the groove and the tension shall be equalized by inserting a suitable tool under the gasket and running it around the pipe 3 times.
2. For pipes manufactured to accept fin type gaskets, the inside surface of the bell or groove and the gasket shall be lubricated as recommended by the manufacturer.

3. After the joint is lubricated, the pipes shall be coupled immediately. The pipes shall be pulled up tightly by using a winch, come-along or other appropriate method. A visual check shall be made to see that the pipe is properly connected.

P. Factory manufactured wye branches or pipe saddles shall be used to connect laterals to the West Whiteland Township sewer main. Field fabricated wye branches and connections are not permitted.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Trenches shall be backfilled with material except where select backfill is deemed necessary by the Design Professional. Backfill and compaction shall occur in lifts not exceeding six inches in depth. The layers shall be individually compacted at is optimum moisture content as determined by ASTM D 1557 to a minimum of 95% of maximum density according to AASHTO T 180.

S. Where sewers are constructed in two or more stages, a temporary pipe plug shall be constructed in the end of the pipe at the termination of each stage.

T. When work is not in progress, and at the end of each work day, securely plug open ends of pipe and fittings to prevent trench water, earth, or other substances form entering the pipes or fittings.

U. The Contractor shall flush each section of pipe as necessary to remove all foreign material which may have entered during construction.

V. Tracer wire shall be installed with the service line.

3.3 CLOSING ABANDONED UTILITIES

A. Close open ends of abandoned underground utilities which are indicated to remain in place. Provide sufficiently strong closures to withstand hydrostatic or earth pressure which may result after ends of abandoned utilities have been closed.

1. Close open ends of concrete or masonry utilities with no less than 8" thick brick masonry bulkheads.
2. Close open end of conduits with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Wood plugs are not acceptable.

3.4 TAP CONNECTION

A. Connect building sanitary drains to nonpressure, gravity-flow sanitary sewer piping as required and in accordance with the building’s plumbing.

B. Make connections to existing conduits and underground structures, so that finished work will conform as nearly as practicable to requirements specified for new work.

C. Use commercially manufactured wyes for branch connections. Field cutting into conduits will not be permitted. Spring flows into existing lines and encase entire wye, plus 6" overlap, with not less than 6" of 4,000 psi 28-day compressive strength concrete.

3.5 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Crushed, broken, cracked, or otherwise damaged piping.
    c. Infiltration: Water leakage into piping.
    d. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.

C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.6 TEMPORARY BYPASS PUMPING

A. The Contractor is required to furnish all materials, labor, equipment, power, maintenance, etc. to implement a temporary bypass pumping system for the purpose of diverting the existing flow around the work area. Bypass pumping system shall be sized to match the capacity of the sewer main.

B. The bypass pumping system shall have sufficient capacity to pump all anticipated average, peak day, and peak hour flows plus additional flows that may occur during a storm event.

C. All equipment shall be designed and manufactured for sanitary sewer service, shall function acceptably, be reliable, and free from leaks or other deleterious environmental impacts. All equipment proposed for use in bypass pumping shall have been maintained per the manufacturer’s recommendations. Equipment service records shall be made available at the Township’s request. Any hoses or pipes that leak shall be removed and replaced with non-leaking hoses or pipes.

3.7 CLEANING AND RESTORATION

A. Clean interior of piping of dirt and superfluous materials.

B. The work area shall be restored to its original or better condition. Restoration includes, but is not limited to, repairs or replacement of footway and curbing that is cracked or broken by the Contractor and replacing brick in brick footways.

END OF SECTION 333000

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Cleanouts.
3. Drains.
4. Manholes.
5. Stormwater inlets.
6. Stormwater detention structures.
7. Pipe outlets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Stormwater inlets: Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:50) and vertical scale of not less than 1 inch equals 5 feet (1:5). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle stormwater inlets according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by the WCASD or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the architect and the WCASD or its representative no fewer than five (5) days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without the architect and the WCASD or its representative written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

A. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS

A. PVC Profile Sewer Piping:

1. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

2.3 DUCTILE IRON PIPE AND FITTINGS

A. All pipe and fittings shall be bituminous coated ductile iron conforming to ANSI specification A 21.51 (C-151), 18 feet nominal length, cement lined B THK A 21.4 AWWA (C-104) (BCL &SC) CTD OD, Tyton joint A 21.11 complete, Class 52.

2.4 CLEANOUT

A. Plastic Cleanouts:

1. Description: PVC Schedule 40 body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2. Cleanout covers to be flush (no raised nuts) with slots for removal.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Precast units shall meet the requirements of PennDOT Publication 408, Section 714.
2. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
3. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
4. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
5. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
6. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
7. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
8. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
9. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
10. Steps: ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
11. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
12. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Precast units shall meet the requirements of PennDOT Publication 408, Section 714.
2. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
3. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
4. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
5. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
6. Steps: ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
7. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
8. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

C. Manhole Frames and Covers:

1. Precast units shall meet the requirements of PennDOT Publication 408, Section 714.
2. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
3. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.
4. Must be heavy duty, capable of supporting HS-20 vehicle loading, in all areas.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4,000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
   a. Invert Slope: 2 percent through manhole.

D. Ballast and Pipe Supports: Portland cement design mix, 4,000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 STORMWATER INLETS

A. Precast units shall meet the requirements of PennDOT Publication 408, Section 714.

B. Curb Inlets: PennDOT Type ‘C’ inlet tops.

C. Gutter Inlets: PennDOT Type ‘M’ inlet tops.

D. Frames and Grates: Heavy duty, capable of supporting HS-20 vehicle loading, in all areas.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure drainage piping according to the following:

1. Piping shall be installed as per PennDOT Publication 408.
2. Install piping pitched down in direction of flow.
3. Install PE corrugated sewer piping according to ASTM D 2321.
4. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
2. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC, Schedule 40, soil pipe fittings in sewer pipes at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Medium-Duty, top-loading classification cleanouts in foot-traffic areas.
2. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
3. Use Extra-Heavy-Duty, top-loading classification cleanouts in road and areas of vehicular concrete and loading docks.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm)] deep. Set with tops 1 inch (25 mm) above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Heavy-Duty, top-loading classification cleanouts in pedestrian and vehicle-traffic service areas.
2. Use Extra-Heavy-Duty, top-loading classification cleanouts in road and areas of vehicular concrete.

B. Embed drains in 4-inch (102-mm) minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in 4-inch (102-mm) minimum concrete around bottom and sides.

3.6 MANHOLE INSTALLATION

A. Precast units shall meet the requirements of PennDOT Publication 408, Section 714.

B. General: Install manholes, complete with appurtenances and accessories indicated.

C. Install precast concrete manhole sections with sealants according to ASTM C 891.

D. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

3.7 CATCH BASIN INSTALLATION

A. Precast units shall meet the requirements of PennDOT Publication 408, Section 714.

B. Construct catch basins to sizes and shapes indicated.

C. Set frames and grates to elevations indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.9 CONNECTIONS

A. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 4,000 psi (20.7 MPa).
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 4,000 psi (20.7 MPa).
3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 4,000 psi (20.7 MPa) unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
   a. Shielded flexible couplings for same or minor difference OD pipes.
   b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure-type pipe couplings for force-main joints.

3.10 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping according to ASTM F 1417.
    c. Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.12 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100

SECTION 337119 - ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nonmetallic duct.

B. Manholes.

1.2 RELATED REQUIREMENTS

A. Section 312316 - Excavation.

B. Section 312323 - Fill: Bedding and backfilling.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 033000 - Cast-in-Place Concrete.

1.3 REFERENCE STANDARDS

A. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures; 2012a.

B. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures; 2010e1.

C. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures; 2011.

D. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures; 2008.

E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

F. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.

G. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.

H. NEMA TC 6&8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations; National Electrical Manufacturers Association; 2003.

I. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation; National Electrical Manufacturers Association; 2004.

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

K. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

L. UL 1684 - Standard For Safety For Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 013300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for nonmetallic conduit and manhole accessories.

C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 CONDUIT AND DUCT

A. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, with fittings and conduit bodies to NEMA TC 3.

B. Reinforced Resin Conduit and Fittings: Complying with UL 1684.
   1. Joining Method: Tapered bell and spigot joints.
   2. Substitutions: See Section 016000 - Product Requirements.

2.2 PRECAST CONCRETE MANHOLES

A. Description: Precast manhole designed in accordance with ASTM C858, comprising modular, interlocking sections complete with accessories.

B. Loading: ASTM C857, Class A-16.

C. Shape: Square.

D. Nominal Inside Dimensions: 4 feet x 6 feet.

E. Inside Depth: 7 feet.

F. Wall Thickness: 6 inches.

G. Base Section: Include 3 inch deep x 14 inch round sump with cast sleeve, and two 1 inch ground rod openings.

H. Top Section: Include 39 inch diameter grooved opening for frame and cover.

I. Riser Casting: 6 inch, with manhole step cast into frame.

J. Frames and Covers: ASTM A48; Class 30B gray cast iron, 27 inch size, machine finished with flat bearing surfaces. Provide cover marked ELECTRIC to indicate utility.

K. Duct Entry Provisions: Window knockouts.

L. Duct Entry Size: 6 inch.

M. Cable Pulling Irons: Use galvanized rod and hardware. Locate opposite each duct entry. Provide watertight seal.

N. Cable Rack Inserts: Minimum load rating of 800 pounds (365 kg). Locate as required for pulling of cables.

O. Cable Rack Mounting Channel: 1-1/2 x 3/4 inch steel channel, 48 inch length. Provide cable rack arm mounting slots on 1-1/2 inch centers.

P. Cable Racks: Steel channel, 1-1/2 x 3/4 x 14 inches, with fastener to match mounting channel.

Q. Cable Supports: Porcelain clamps and saddles.

R. Manhole Steps: Polypropylene plastic manhole step with 1/2-inch steel reinforcement.

S. Source Quality Control: Inspect manholes in accordance with ASTM C1037.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

C. Verify locations of manholes prior to excavating for installation.

D. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.

E. Manhole locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.

3.2 DUCT BANK INSTALLATION

A. Install duct to locate top of ductbank at depths as indicated on drawings.

B. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.

C. Cut duct square using saw or pipe cutter; de-burr cut ends.

D. Insert duct to shoulder of fittings; fasten securely.

E. Install no more than equivalent of three 90-degree bends between pull points.

F. Provide suitable fittings to accommodate expansion and deflection where required.

G. Stagger duct joints vertically in concrete encasement 6 inches minimum.

H. Use suitable separators and chairs installed not greater than 4 feet on centers.

I. Band ducts together before backfilling.

J. Securely anchor duct to prevent movement during concrete placement.

K. Place concrete under provisions of Section 033000. Use mineral pigment to color concrete red.

L. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.

M. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.

N. Provide suitable pull string in each empty duct except sleeves and nipples.

O. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

P. Interface installation of underground warning tape with backfilling. Install tape 12 inches below finished surface.

3.3 PRE-CAST MANHOLE INSTALLATION

A. Excavate for manhole installation under the provisions of Section 312316.

B. Install and seal precast sections in accordance with ASTM C891.

C. Install manholes plumb.

D. Use precast neck and shaft sections to bring manhole cover to finished elevation.

E. Attach cable racks to inserts after manhole installation is complete.

F. Backfill manhole excavation under the provisions of Section 312323.

END OFSECTION 337119