Project Manual

Volume 3

Prepared for:

West Whiteland Township
101 Commerce Drive
Exton PA, 19341

Project:
New Construction of:
Public Works Facility
121 Valley Creek Boulevard
Exton, PA 19431

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SECTION 21 0100 - 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 CUTTING AND PATCHING:

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

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

C. All cutting and patching of every nature required in connection with these Contracts shall be done by each Contractor with mechanics experience in their respective lines of work. All patching shall match adjacent finishes.

D. All cutting in the building shall be done with great care so as not to leave an unsightly surface which may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through the fault of the Contractor, he shall be required at his own expense, to engage the General Contractor to replace the damaged materials with new materials.

E. Cutting and patching of the existing building shall be done by this Contractor. All holes cut shall be in a manner approved by the Architect and all patching shall be done so as to match the existing construction and finish. The Contractor shall patch all openings left in present walls, floors and ceilings when ductwork, piping and other materials are removed.

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

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

1.3 GUARANTEE:

A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a minimum period of one year, or as noted otherwise in front end specification sections from date of acceptance by Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.

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

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

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 OPERATION AND MAINTENANCE INSTRUCTIONS:

A. Upon the completion of this project, the Contractor shall deliver to the Architect for approval, three copies of an operating and maintenance manual consisting of the items outlined hereinafter.

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

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

D. 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.

E. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and trouble shooting techniques.

1.9 PAINTING:

A. Provide corrosion inhibiting prime coating on all exterior piping and ferrous materials.

B. Where painting of exposed piping is to be performed by others, contractor shall clean all piping and prepare piping for final painting by others.

1.10 EARTHWORK:

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

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

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

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

END OF SECTION 21 0100

SECTION 21 0500 - 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 21 0553 - 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 BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2010.

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.

D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2011.

E. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.

F. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2012.

G. ASME B16.11 - Forged Fittings, Socket-welding and Threaded; 2011.

H. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

I. ASME B16.25 - Buttwelding Ends; 2012.

J. ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2004.

K. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).

L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

M. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2009 (Reapproved 2014).

N. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.

O. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2015.

P. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).

Q. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2013.

R. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.

S. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

T. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.

U. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.

V. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2012.

W. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.

X. AWWA C606 - Grooved and Shouldered Joints; 2015.

Y. FM (AG) - FM Approval Guide; current edition.

Z. ITS (DIR) - Directory of Listed Products; current edition.

AA. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2013

AB. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2013

AC. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.4 SUBMITTALS

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

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

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
   1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

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

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

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Division 01 - Product Requirements, for additional provisions.
   2. Extra Valve Stem Packings: Two for each type and size of valve.

1.5 QUALITY ASSURANCE

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

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

C. Conform to UL requirements.

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

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

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

1.7 EXTRA MATERIALS

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

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

PART 2 - PRODUCTS

2.1 FIRE SUPPRESSION SYSTEMS

A. Sprinkler Systems: Conform work to NFPA 13, IBC 2015, and IFC 2015, requirements of the Local A.H.J., and minimum requirements as indicated on FP Drawings and Division 21 Specifications.

2.2 BURIED PIPING

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

2.3 ABOVE GROUND PIPING

A. Acceptable Manufacturers for Piping and Tubing:
   1. Allied Tube - Sprinkler; 16100 S. Lathrop Avenue, Harvey, IL 60426.
   2. Bull Moose Tube Company, 1819 Clarkson Rd., Chesterfield, MO 63017
   3. Wheatland Tube Company; 900 Haddon Ave., Collingswood, NJ 08108-2162.

B. Threaded and Welded Steel Pipe(2" and smaller): Schedule 40 Sprinkler Pipe: ASTM A795, Type E, Grade A; or Schedule 40 Pipe ASTM A-53. UL listed and FM approved for use as sprinkler piping. Black mill coating.
   1. Dry System Piping - Hot-dipped galvanized to meet FM requirements for dry systems in accordance with the zinc coating specification of ASTM A795 or A53.

C. Grooved Steel Pipe: Schedule 10 Sprinkler Pipe: ASTM A135, Grade A. UL listed and FM approved for use as sprinkler piping. Black mill coating.
   1. Dry System Piping - Hot-dipped galvanized to meet FM requirements for dry systems in accordance with the zinc coating specification of ASTM A795 or A53.

D. Fittings:
   1. All fittings shall be pressure rated for minimum 250 psig working pressure.
   2. Welded Steel Fittings: ASME B16.9, wrought steel, buttwelded, ASTM A 234/A 234M, wrought carbon steel or alloy steel, or ASME B16.5, steel flanges and fittings. Welding Materials in accordance with ASME Code.
   3. Threaded Malleable Iron Fittings: ASME B16.3, Class 300, threaded fittings.
   4. Mechanical Grooved Fittings as manufactured by Victaulic ONLY: ASTM A536 ductile iron or ASTM A53 carbon steel fittings with grooved ends designed to accept Victaulic couplings. FireLock® or standard fittings.

5. Mechanical Grooved Couplings as manufactured by Victaulic ONLY: Ductile iron housing clamps with tapered seat to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
   a. Saddle type - U-bolt style hole cut Mechanical -T's shall not be permitted for use on this project. Hole cut Mechanical-T's shall be Victaulic Style 920 or 920N and installed in strict accordance with manufacturers instructions.
   b. Rigid Couplings: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.
      1) 1-1/4” to 4”: “Installation Ready” stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock® EZ Style 009.
      2) 5” and Larger: Standard rigid coupling. Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
      3) Flexible Couplings: Use in seismic areas where required by NFPA 13.
         (a) 2” to 6”: “Installation Ready” stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic™.
         (b) 8” and Larger: Standard flexible coupling. Victaulic Style 75 or 77.
         (c) Coupling gaskets shall be listed for use as follows:
      4) Coupling gaskets shall be listed for use as follows:
         (a) Dry System(Ambient Temperature) - FlushSeal® or EZ Style 009 design, Grade EPDM, Type A
         (b) Dry Freezer Applications(-30°F to 0°F) - FlushSeal®, Grade L, Silicone
         (c) Wet System(Ambient Temperature) - C-Shape or EZ Style 009 design, Grade EPDM, Type A
   c. Flanged Adapters: ASTM A536 ductile iron casting, flat faced, designed for incorporating flanged components with ANSI Class 150 bolt-hole pattern. Victaulic Style 741.

2.4 PIPE HANGERS AND SUPPORTS

A. Acceptable Manufacturers for Piping Hangers and supports:
   1. TOLCO Inc.
   2. Grinnell
   3. Provide hangers and supports as manufactured by the listed acceptable manufacturers or equal as approved by owner/architect.

B. Hangers for Pipe Sizes 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.

2.5 GATE VALVES

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

2.6 GLOBE OR ANGLE VALVES

A. Up to and including 2 inches:
   1. Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity repackable under pressure.

B. Over 2 inches:
   1. Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.7 BALL VALVES

A. Up to and including 2 inches:
   1. Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends with union.

B. Over 2 inches:
   1. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 10 inches and over, flanged.

2.8 BUTTERFLY VALVES

A. Bronze Body(up to 2 inches):
   1. UL Listed, FM approved, Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device and preinstalled supervisory switch.
   2. Ductile Iron Body(up to 4 inches)
      a. UL Listed, FM approved, Ductile iron body, nickel plated ductile iron disc, Nitrile seat, Type 416 stainless steel two-piece stem, TFE-lined stainless steel bearings, weather-proof actuator with pre-wired supervisory switches. Victaulic Series 765 (365 psi) and Series 705 (300 psi).

2.9 CHECK VALVES

A. 2 inch to 3 inch:
   1. UL Listed, FM approved, ductile iron body, CF8M stainless steel disc, stainless steel spring, and brass shaft, nickel-plated seat with Nitrile o-ring, grooved ends, 365 psig maximum pressure rating. Victaulic Series 717H.

B. 4 inch to 12 inch:
   1. UL Listed, FM approved, ductile iron body, EPDM coated ductile iron disc, stainless steel spring and shaft, welded-in nickel seat, grooved ends, 300 psig maximum pressure rating. Victaulic Series 717.

2.10 DRAIN VALVES

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

2.11 SLEEVES:

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

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

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

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

2.12 ESCUTCHEONS:

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

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

2.13 ACCESS DOORS AND PANELS:

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

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

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

2.14 ANCHOR BOLTS:

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

PART 3 - EXECUTION

3.1 PREPARATION

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

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

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

3.2 INSTALLATION

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

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

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

D. Group piping whenever practical at common elevations.

E. Provide sleeves when penetrating footings, floors, and walls and fill annular space between piping and sleeves.
   1. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
   2. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved UL Listed fireproof material. The entire penetration assembly shall be UL Listed to achieve fire resistance equivalent to fire separation required for the wall or floor.

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

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

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

I. Perform welding In accordance with ASME Code.

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

K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 9000.

L. Do not penetrate building structural members unless indicated or as approved in field by Structural Engineer.

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

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

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

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

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

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

END OF SECTION 21 0500

SECTION 21 0553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.2 RELATED REQUIREMENTS

A. Section 09 9000 - Painting and Coating: Identification painting.

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

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

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

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

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

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

PART 2 PRODUCTS

2.1 GENERAL

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

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

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

2.2 NAMEPLATES

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

2.3 TAGS

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

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

2.4 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
   2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
   3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
   4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.

B. Stencil Paint: As specified in Section 09 9000, semi-gloss enamel, colors conforming to ASME A13.1.

2.5 PIPE MARKERS

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

2.6 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. Sprinkler Valves: Black.

PART 3 EXECUTION

3.1 PREPARATION

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

B. Prepare surfaces in accordance with Div.1 specifications for stencil painting.

3.2 INSTALLATION

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

B. Attach tags to all valves with corrosion resistant chain.

C. Provide additional labelling including but not limitted to equipment tags, room labels, etc., for location of equipment and valving as required by the Authority Having Jurisdiction. Coordinate work with Architect in field.

D. Identify equipment with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

E. Identify valves in main and branch piping with tags. Identify auxilliary drains and any piping specialty required for maintenance and operation of the system with nameplates indicating the function of the specialty.

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

G. Identify piping, concealed or exposed, with plastic pipe markers or Stecil painting (permitted within mechanical spaces). Verify requirements for exposed piping identification in finished areas with Architect in field. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification on horizontal piping not to exceed 20 feet on straight runs and at each side of penetration of structure or enclosure. Locate additional identification on risers and drops, adjacent to each Tee of main piping, and at each obstruction.
   1. Install plastic pipe markers in accordance with manufacturer's instructions.
   2. Apply stencil painting in accordance with Div. 1 specifications.

H. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 21 0553

SECTION 21 1300 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. System design, installation, and certification.

C. Sprinkler Heads and Accessories

D. Sprinkler Alarm Valves

E. Supervisory and Monitoring Devices

F. Sprinkler System Fire Department Connections

G. Sprinkler System Accessories and Equipment

1.2 RELATED REQUIREMENTS

A. Section 07 8413 - Penetration Fireproofing

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

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

D. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

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

B. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2013.

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

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturers data on all products specified within this section including sprinklers, valves, and specialties. Clearly Indicate exact models/model numbers, options, and accessories to be provided. Indicate the application where the materials are to be used where appropriate. Manufacturers data shall include the following information as appropriate for each product: product listings (UL, FM, ASSE, etc.) performance ratings, rough-in details, weights, support requirements, and piping connections.

C. System Drawings:
   1. Contractor shall prepare drawing submittals and hydraulic calculations for submittal to the Architect/Engineer, all local reviewing agencies having jurisdiction, and the owner's insurance carrier (I.S.O submittal necessary only when required by owner's insurance carrier). The shop drawings prepared by the contractor shall bear a fire protection engineer's seal, whom is registered in the Commonwealth of Pennsylvania. No work shall begin until all approvals are granted.
   2. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
   3. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
   4. Submit shop drawings to authority having jurisdiction, and Fire Marshall for approval. Submit proof of approval to Architect.
   5. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
   6. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
   7. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
   8. Maintenance Materials: Furnish the following spare equipment for Owner's use in maintenance of project.
      a. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
      b. Sprinkler Wrenches: For each sprinkler type.
   9. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.5 QUALITY ASSURANCE

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

1.6 PRE-DESIGN MEETING

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 TESTING

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

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

1.9 EXTRA MATERIALS

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

B. Provide suitable wrenches for each sprinkler type.

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

PART 2 - PRODUCTS

2.1 SPRINKLER SYSTEM

A. Provide a “Design Build” Fire Suppression Sprinkler System in accordance with IBC2018 and NFPA 13, and inclusive of all additional requirements as indicated on the drawings and in these specifications. The entire building shall be "sprinklered throughout" with "Quick Response" standard coverage sprinklers. No Extended coverage heads shall be permitted except where specifically noted on the Fire Protection drawings. The Fire Suppression Sprinkler System shall be hydraulically calculated to provide the prescribed density uniformly over the most remote area in accordance with NFPA13. Provide Manual Wet standpipes in all stair towers indicated on drawings

1. Occupancy: Building predominantly Light Hazard, some areas of other classification in accordance with NFPA 13 and document drawings.
2. Water Supply:
   a. Date: Feb., 18 2022 (2:15 pm).
      1) Monitor Hydrant: Hydrant #58-145 - Valley Creek Blvd. 1037 ft. S/O Swedesford Rd.
         (a) Static pressure: 122 psi
         (b) Residual pressure: 92 psi
      2) Flow Hydrant: Hydrant #58-146 - Valley Creek Blvd. and Swedesford Rd.
         (a) Flow: 1443gpm@ 74psi pitot pressure
   b. The above flow test information is provided as basis of design for the contract documents. The fire protection contractor shall perform a water flow test at time he is preparing his hydraulic calculations and use the results of his flow test as the basis for design of the "Design Build" sprinkler system.

B. Interface system with building control system.

C. Provide Wet Manual Standpipes with hose connection valves where indicated on the FP drawings. Provide hose connection valves within recessed Cabinets. Refer to drawings for locations.

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

2.3 SPRINKLER HEADS AND ACCESSORIES

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

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

C. Concealed Pendant Type (with matching push on escutcheon plateSuspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
   1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
   2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
   4. Design Basis: Victaulic Model V38 series (Quick Response).

D. Dry Concealed Pendant Type (with matching push on escutcheon plateSuspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
   1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
   2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
   4. Galvanized steel dry basrrel with stainless steel inner tube
   5. Design Basis: Victaulic Model V33 series (Quick Response).

E. Dry, Flexible Style, Concealed Pendent/ Pendent/ Horizontal Sidewall Type (with matching push on escutcheon plate Suspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
   1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
   2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
   4. Flexible hose: UL listed FM approved SS braided hose
   5. Design Basis: Victaulic Model V35 series (Quick Response).

F. Standard Upright or Pendent type, with guard (Exposed Sprinkler Areas) - Quick Response
   1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
   2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
   3. Design Basis: Victaulic Model V27 series (Quick Response).

G. Dry Standard Upright, with guard (Exposed Sprinkler Areas) - Quick Response
   1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
   2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
   3. Galvanized steel dry basrrel with stainless steel inner tube
   4. Design Basis: Victaulic Model V36 series (Quick Response).

H. Dry Standard Pendant, with guard (Exposed Sprinkler Areas) - Quick Response
   1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
   2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
   3. Galvanized steel dry basrrel with stainless steel inner tube
   4. Design Basis: Victaulic Model V36 series (Quick Response).

I. Sidewall Type: Quick Response, Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
   1. Finish: Enamel, color as selected.
   2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
   4. Design Basis: Victaulic Model V27 series (Quick Response).

J. Guards: Finish chrome.

K. Flexible sprinkler connections: In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System [with captured coupling Style 108] may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
   1. Captured Coupling IGS Groove Style 108: Single-bolt, consisting of two ductile iron housings, Grade E “EPDM” gasket, and a zinc electroplated steel bolt and nut conforming to ASTM A449.
   2. The drop shall include a UL-2443 approved and FM-1637 listed series AH2 braided hose with bend radius to 2” to allow for proper installation in confined spaces. The hose shall be listed for (5) bends at 36” length, (7) bends at 48” length, (9) bends at 60” length and be listed for (5) bends at 36” length, (7) bends at 48” length, (9) bends at 60” length and (10) bends at 72” length.
   3. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed for sprinkler services to 175 psi. and and FM Approved to 200 psi.
   4. All hoses shall be factory-pressure tested to 400 psi.
   5. AB6 Bracket Assembly, for use in cold storage applications with Victaulic Model V36 dry sprinklers.
   6. Approvals:
      a. FM-1637
      b. UL 2443
   7. Refer to the Victaulic I-VICFLEX installation manual and the Victaulic VicFlex™ Design Guide, as shown in product submittal 10.85 to ensure proper installation.

2.4 FIRE PROTECTION SERVICE ENTRANCE BACKFLOW PREVENTER

A. Acceptable Manufacturers
All backflow prevention devices shall be provided by from a single manufacturer.
1. Ames Co..
2. Watts.

B. Double Check Valve Assembly type (DCVA), U.L. Listed/FM approved, resilient wedge OS&Y gate valves, 300 series SS body and all internal parts, lead-free waterway construction, two independently operated tri-link check modules with reversible elastomer discs, single sleeve 304SS Sch.40 housing with grooved fittings. Rated working pressure 175psi. Standards/Approvals ASSE1015, AWWA C551-92, CSA B64.5, Foundation for Cross-Connection Control and Hydraulic Research at The Unversity of Southern California (FCCCHR-USC) CContractor shall submit backflow preventer information to Water Authority for approval and coordinate all requirements with Water Authority in field prior to order.
1. Design Basis: Watts Model 757DCA-OSY.

2.5 WET PIPE SPRINKLER RISER-CHECK VALVE

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

B. Check type valve with a spring-assisted, single disc design which provides a leak-free seal with as little as 5 ft/1.5 m of head. The valve shall feature a single disc mechanism incorporating a spring-assisted feature for non-slamming operation, as well as upstream and downstream pressure taps. Each valve to be factory tested to the rated working pressure.
1. Design Basis: Victaulic FireLock® Series 717R and 717HR.

2.6 FLUSH MOUNT SPRINKLER SYSTEM FIRE DEPARTMENT CONNECTION

A. Acceptable Manufacturers
   1. Potter Roemer.
   2. Croker.
   3. Guardian Fire Equipment

B. Type: Siamese Flush Wall Mount type.
   1. Outlets: Chrome plated, flush wall mount, siamese connections with style/threads as required by local fire department. Verify all requirements with local Fire Marshal Prior to Order/Installation Provide threaded dust cap and chain of matching material and finish.
   2. Drain: 3/4 inch automatic drip. Refer to FP detail drawings for additional installation details.
   3. Inlet: 4"NPT Back/Top/Bottom (as required by piping arrangement
   4. Wall Plate/Label: Polished Brass or polished chrome plated brass verify with Architect Prior to order.
      a. Lettering: "AUTO. SPKR.. STANDPIPE". Verify all signage requirements with local Fire Marshal Prior to submittal and Order/Installation.
   5. Design Basis: Potter Roemer: Model 5021-D/5022-D/5023-D

C. Type: 5" Storz x 4"NPT Flush mounted wall type.
   1. Outlets: Connections with style/threads as required by local fire department. Verify all requirements with local Fire Marshal Prior to Order/Installation Provide threaded dust cap and chain of matching material and finish.
   2. Wall Plate/Label: Polished Brass or polished chrome plated brass/"AUTO. SPKR.. STANDPIPE". Verify all signage requirements with local Fire Marshal Prior to submittal and Order/Installation.
   3. Design Basis: Potter Roemer: Model 5795-03 w/5962-B wall plate

2.7 FLUSH MOUNT BACKFLOW PREVENTER TEST CONNECTION

A. Acceptable Manufacturers
   1. Potter Roemer.
   2. Croker.
   3. Guardian Fire Equipment

B. Type: Flush Wall Mount type.
   1. Outlets: Connections 2-1/2" NST threads, 2-1/2" hose valves with caps and chains
   2. Finish: Chrome Plated
   3. Drain: 3/4 inch automatic drip.
   4. Inlet: 4"NPT Back/Top/Bottom (as required by piping arrangement
   5. Wall Plate/Label: Polished chrome plated brass (verify with Architect Prior to order)
      a. Lettering: "TEST CONNECTION". Verify all signage requirements with local Fire Marshal Prior to submittal and Order/Installation.
   6. Design Basis: Potter Roemer: Model 5862-D(two valve)/5863-D(Three valve)/5864-D(Four Valve)

2.8 ELECTRIC HORN/STROBE

A. Acceptable Manufacturers
*All electric notification devices shall be provided by from a single manufacturer.
1. SimplexGrinnell.
2. Wheelock.

B. U.L. listed, Weatherproof A/V horn/strobe, red cover with white lettering, regulated 24 DC, with weatherproof mounting box.
1. Design Basis: SimplexGrinnell True Alert Model 4906-9131 w/Model 4905-9828 weatherproof box.

C. Coordinate exact location and mounting with Local AHJ and coordinate required wiring to fire alarm panel with E.C. in field.

2.9 WATER FLOW SWITCH

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

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

2.10 PRESSURE SWITCH

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

B. Pressure switch for mounting in upright position, with two contacts; rated 15 amp at 125 volt AC and 2.5 amp at 30 volt DC.

2.11 SUPERVISORY SWITCH

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

C. Provide fire hose connection stations including hose connection valve and valve cabinets as indicated on plans with sufficient clearance from walls, obstructions, or adjacent structure to allow unobstructed access to hose connection. Verify exact locations, height above floor, door swing, threads, signage, and required accessories with the Local AHJ prior to order/installation.

D. Provide Fire Department Connections (FDC) at locations indicated on plans. Verify all Fire Department Connection details including style, connection type, height above grade, size, threads, and signage with local Fire Marshal or Fire Department prior to order/installation.

E. Locate outside horn strobe alarm on building wall above all fire department connections, outside room containing the fire protection service entrance valving, and as indicated on plans.

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

G. Provide penetration firestopping for all work of Div. 21 in accordance with Div. 07 specifications.

H. Field coordinate all exposed piping in finished spaces with Architect prior to fabrication or installation of piping. This field coordination of proposed pipe routing shall include on site review of submittal drawings with Architect and any other trades affected by the work.

I. In areas with finished ceilings, place piping in concealed spaces above finished ceilings. Coordinate piping locations between all trades prior to installation and final design. In exposed structure areas, all pipe routing shall be reviewed in field with Architect for final approval prior to installation of any work.

J. 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.

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

L. 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.

M. Flush entire piping system of foreign matter.

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

O. Provide system tests at locations as required by NFPA-13. Pipe all system test drains to building exterior in location approved by Architect , Owner , and AHJ.

P. Hydrostatically test entire system in accordance with NFPA-13.Coordinate testing to be witnessed by Fire Marshal and authority having jurisdiction.

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

R. Provide identification for sprinkler system components and piping in accordance with Section 210553. Provide riser tags including hydraulic calculation information at all riser alarm valves and floor control assemblies

S. Provide laminated color coded Zone Maps to be displayed at main building fire alarm panel. Coordinate all requirements with local Fire Marshal prior to installation.

3.2 INTERFACE WITH OTHER PRODUCTS

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

3.3 SCHEDULES

A. System Hazard Areas:
   1. Lobby/Vestibules, Offices, Corridors, Toilet/Locker rooms, and similar spaces: Light Hazard.
   2. Garage(parking), Storage Spaces, Janitors Closets, and similar spaces: Ordinary Hazard, Group 1.
   3. Garage(repair), Work/Fabrication areas, and similar spaces: Ordinary Hazard, Group 2.

END OF SECTION 21 1300

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SECTION 22 0100 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION OF WORK:

A. Work covered by this Division of the Specifications shall consist of the furnishing of all material, equipment, apparatus, tools, and labor and installation services required to provide the mechanical systems, such as they are specified and shown, in an acceptable operating condition.

B. General description of the work associated with each major classification of mechanical work is included in the Scope of the Work in various Sections. Other items of mechanically related work are shown on the mechanical drawings.

C. Contractor shall provide all labor and materials that may be required, or as directed, to test, adjust, retest and readjust the mechanical systems in order for them to operate satisfactorily. Architect shall determine what is satisfactory.

D. Contractors shall visit the site during the bidding period and become familiar with all of the existing conditions, which could influence the work in the Contracts.

E. Refer to Division 01 specifications and Summary of Contracts for additional requirements.

1.3 CONTRACTOR:

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

1.4 DRAWINGS:

A. The Heating, Ventilating, Air Conditioning, Fire Protection and Plumbing Systems are indicated on the respective Plans, but attention is called to the fact that certain pertinent information and details may appear on Architectural Plans, and these will become a part of each Contract. The Architectural and Mechanical/Electrical/Plumbing Plans are intended to be complimentary. In the event of any discrepancies between them or between any of the Plans and these Specifications, the Architect shall be notified promptly and will issue his interpretation to all interested parties. So far as arrangement of equipment, fixtures, and appurtenances to conform with construction conditions is concerned the Architectural Plans and Details shall govern, rather than the MEP Drawings.

1.5 TRUE INTENT:

A. The Drawings and Specifications are intended to provide a complete and perfectly operating system. Therefore, it is specifically agreed and understood by the Contractor that anything, be it labor, material or equipment, which is not described in the Specifications or specifically shown on the Drawings, but is necessary for the operation and completion of a perfectly operating system, according to the true intent of the Specifications and Drawings and as interpreted by the Architect, shall be furnished by the Contractor as a part of his Contract, at no extra charge, as though it were specifically detailed and described.

1.6 DEFINITIONS:

A. Where the word "provide" is used in connection with a system, equipment, or an item it shall be understood to mean the furnishing and installing of the system, equipment or item on this project.

B. Where the phrase "as directed" is used, it shall be understood to mean as directed or instructed by the Architect or his authorized representative.

C. Where the word "shall" appears in these Specifications, it shall be understood to mean that the labor, material or performance which it describes, or is associated, is mandatory.

D. Where the words "to be" appear in these Specifications, it shall be understood to have the same interpretation as if the word "shall be" were inserted in their place.

E. Where the word "comparable" appears in these Specifications, it shall be understood to mean that any item of equipment or material which is specified with an absolute minimum of differences.

1.7 VISIT TO SITE:

A. Attention is directed to the necessity for all the various Contractors to visit the site and examine all conditions affecting the proper execution of their Contracts. Submission of proposals shall be considered evidence that Contractors have visited and examined the site.

B. Existing contours and topography as indicated, are believed to be reasonably correct, but are not guaranteed. Where conditions at project site do not agree exactly with conditions as indicated, Contractor shall assume all responsibility for said discrepancy.

C. No extra payment will be allowed Mechanical Contractors for extra work caused by failure to visit, examine and clarify.

1.8 LINES, GRADES AND SURVEYS:

A. All necessary surveys, lines, grades and measurements are the responsibility of the Contractor desiring the information for the proper installation of his work. The Contractor shall verify all lines, grades and dimensions as shown on the Drawings. The Contractor will verify all lines and grades with the local controlling agency.

B. Grades, elevations, and locations shown on the Drawings are approximate and the Contractor shall verify all such information on the site before proceeding with the work.

1.9 METHOD OF PROCEDURE:

A. The Drawings accompanying these Specifications are diagrammatic and intended to indicate the approximate and relative locations of the Mechanical and Plumbing Systems.

B. Installation, connection and inter-connection of all components of the Mechanical and Plumbing Systems shall be complete and made in accordance with the manufacturer's instructions and best practices of the respective trades.

C. Each Contractor shall erect all parts of equipment to be furnished under his Contract at such time and in such manner as not to delay or interfere with any Contractor performing work at that time.

D. The Contractor shall coordinate their work with all other Contractors as to the locations of different lines of pipe, ducts, conduit, and electrical equipment before erecting any work, so as to avoid interference or conflicts. In case of conflict, equipment/piping shall be relocated, without additional cost to the Owner, as directed by the Architect regardless of which equipment/piping was installed first. Each Contractor shall cooperate with other Contractors for the proper securing and anchoring of all work included within these Specifications.

E. Extraordinary care shall be used in the erection and installation of all equipment and materials to avoid marring surfaces of the work of other Contractors, as each Contractor will be held responsible for all such damage caused by the lack of precaution and due to negligence on the part of his workmen.

1.10 LAWS, ORDINANCES AND REGULATIONS:

A. All Plumbing Systems in all and/or part shall conform to all pertinent laws, ordinances and regulations of ALL bodies having jurisdiction, at all governing levels, notwithstanding anything in these Plans or Specifications to the contrary. In case of conflict between governing levels, the more stringent laws shall apply.

B. Each Contractor shall refer to Division 01 specifications for permit and fees responsibilities required for completion of their work. Certificates of completed inspections required by the Authority Having Jurisdiction, and these specifications, shall be delivered to the Architect. Final payment is contingent upon delivery of such Certificates to Architect.

1.11 FIRE UNDERWRITER SEAL:

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

1.12 CONCRETE AND MASONRY WORK:

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

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

1.13 MATERIALS AND EQUIPMENT:

A. All materials and equipment shall be new, and shall conform to the grade, quality and standard specified herein. All materials and equipment utilized shall be manufactured in the United States of America.

B. All equipment offered under these Specifications shall be limited to products regularly produced and recommended for service, in accordance with engineering data, rating, or other comprehensive literature made available to the public and in effect at the time of opening of bids.

C. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. These Contractors shall obtain these instructions, which shall be considered part of these Specifications. Type, capacity and application of equipment shall be suitable and shall operate satisfactorily for the purpose intended in the respective Mechanical Systems.

D. Equipment shown on the Drawings illustrates the general space requirements and each Contractor shall install only such equipment, which shall not necessitate changes in the building or arrangements. If changes are required due to substitution the contractor shall pay ALL costs stemming from such change. No such changes shall be made except with Architect's written approval.

1.14 ANCHOR BOLTS:

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

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

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

1.15 NOISE AND VIBRATION:

A. Particular care shall be exercised in the selection and installation of all equipment and components to attain reasonable noise levels in occupied spaces. In general, sound levels for various spaces shall be maintained in accordance with the recommendations of the ASHRAE Guide. Normally the classification of noise shall be by mutual agreement but should a dispute arise regarding sound levels after occupancy of the building, representative sound measurements shall be taken to determine the average noise level in the offending space.

1. Measurements shall be made with a calibrated sound meter, using the flat response network in decibels (db), and shall be taken first with doors and windows closed and mechanical equipment shut down. Upon completion of the measurements, the mechanical equipment shall be started and similar readings shall be taken. If the recorded increase is in excess of the maximum noise increases indicated in the following tabulation, suitable correction shall be made by the Contractor at no cost to the Owner.

2. Type of Space ---------- Noise Increase

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

1.16 SOUND ISOLATION:

A. All equipment and piping shall be installed so that no noise or vibration is transmitted to any part of the building beyond the room or rooms in which such noise or vibration is generating. Moving equipment shall be isolated from the concrete foundations or floors by cork where required to prevent transmission of noise of vibration.

B. Silencers shall be installed in water connections to quick closing devices. Shock absorbers shall be used in all pipe lines where required to eliminate noise.

C. Any and all other insulation or isolation required to accomplish the results specified above shall be furnished and installed without additional cost to the Owner.

1.17 ESCUTCHEONS:

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

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

1.18 ACCESS DOORS AND PANELS:

A. Refer to Section 08 3113 - "Access Doors and Frames" for specific requirements. Where requirements are not specified in Section 08 3113, the following rquirements of this section shall apply.

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

C. Panels shall be of suitable size and construction for each specific location. Doors shall be flush and shall open 175 degrees on concealed hinges. All assemblies shall be rustproof. All assemblies within painted walls or ceilings shall have all exposed finished edges and surfaces prime-coated with rust inhibitive paint. All assemblies within tiled wall areas shall be constructed of 304Stainless steel or equivalent. Doors to be installed in ceilings shall be with screw driver operated cam locks. Doors for wall installation shall have master-keyed cylinder locks. Doors shall be Milcor, or equal, as follows:

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

1.19 CUTTING AND PATCHING:

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

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

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

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

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

F. All cutting in the building shall be done with great care so as not to leave an unsightly surface which may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through the fault of the Prime Contractor, he shall be required at his own expense, to engage the General Contractor to replace the damaged materials with new materials.

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

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

I. Contractor shall seal all piping penetrations through all walls and floors. Penetrations through fire rated walls or floors shall be sealed with an approved UL Listed fire sealant.

1.20 ANCHORS:

A. Direct all pipe motion to expansion bends, loops, or joints by heavy pipe clamps and/or structural steel sections welded to pipe lines and clamped or welded to structural members as directed by the Architect. Points at which anchors are located and secured shall be approved by the Architect so that no structural members shall be unduly strained. Where possible, anchor points shall be on members running parallel to the piping being anchored.

1.21 FLASHING:

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

1.22 PRESSURE VESSELS:

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

1.23 STORAGE:

A. Each Contractor shall provide suitable storage facilities in the location assigned him at the site for his materials. Where parts of the building are used for such storage, they shall be left in condition satisfactory to the Architect.

B. All materials delivered on the premises or materials stored at the Contractor's place of business or in warehouses, which are to form a part of the work and for which the Contractor has submitted an application for payment, shall be considered the property of the Owner and shall not be removed, sold or used for other purposes without his consent.

C. The Contractor has the right to remove all his surplus materials after completion of the work.

1.24 RUBBISH REMOVAL AND CLEAN-UP:

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

1.25 ELECTRICAL CONNECTIONS:

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

1.26 TESTS:

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

1.27 PROTECTION:

A. Each Contractor shall effectively protect his work and materials with tarpaulins of heavy plastic material against dirt, water, chemicals, plaster, or damage during the whole period of installation or until he is directed to remove the coverings by the Architect. Any damaged material must be removed and replaced by the Contractor without additional cost regardless of the cause of the damage. All openings in pipes, fittings, ductwork, conduit, etc., must be effectively sealed to exclude dirt, sand, and other foreign substances.

B. In areas where the wall finish consists of ceramic tile, metal fittings shall not be installed until the walls have been acid cleaned.

1.28 GUARANTEE:

A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship. The guarantee period shall be as specified in Division 01 specification sections, beginning from date of final acceptance and turnover to Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.

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

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

1.29 CLEANING OF SYSTEMS:

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

B. All strainers shall be opened and cleaned thoroughly.

1.30 INSTRUCTION TO EMPLOYEES:

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

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

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

1.31 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS:

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

B. Shop drawings and equipment submittals shall be submitted to and be approved by the Architect before any work is accomplished. They shall clearly indicate the location, service and function of each particular item. Submittals shall be in the form of manufacturers printed catalogs, pamphlets, for which approval is requested. Identification of model to be supplied and all options shall be made in ink. Shop drawings and submittals shall both be completely referenced and identified. Descriptive information and data on submittals shall be complete. Those drawings and submittals, which only show partial or general information will not be acceptable and will be returned to the Contractor.

C. Contractor shall include in writing, any deviations in the submittals and shop drawings where such deviations are a departure from the Contract Documents. This written advisory shall accompany the initial submittal and shall state the reasons for the deviations.

D. Shop drawings and submittals which are to be prepared by the various subcontractors and equipment suppliers shall first be sent to the Contractor for checking and eventual formal submission to the Architect. Contractor shall check these drawings and submittals with respect to measurements, materials, identifications, and details so as to make certain that they conform to the intent of the Contract Documents. Drawings and submittals which are found to be inaccurate or otherwise in error shall be returned by the Contractor to originating party for correction before submission to the Architect for approval.

E. Architect/Engineer shall check the shop drawings and submittals to see if they conform with the design concept for this project and whether they comply with the information given in the Contract Documents. Contractor shall be responsible for dimensions that are to be confirmed and correlated at the job site, for coordination in the ordering and assembly of mechanical equipment, for information that pertains solely to fabrication processes or to techniques of construction, and for coordination of the work of all trades.

F. The following specific items and information shall be included:
   1. All optional accessories as specified in the specifications and drawings clearly noted.
   2. Capacity and performance data as shown on the Equipment Schedules or as specified. Complete descriptive data on the equipment so that compliance with the Specifications can be ascertained.
   3. Submittals for all valves, specialties, and miscellaneous items which are specified, scheduled, or shown.
   4. Electrical wiring diagrams (power and control) that show the complete control of electric motor driven equipment which is to be furnished by Division 15.

G. Plumbing systems and equipment which have been installed without having been previously approved by the Architect/Engineer may be condemned by him. They shall be removed if so condemned and be replaced with systems and equipment that are approved. This work shall be done without any additional cost to the Owner.

H. Shop drawings and equipment submittals shall be revised as often as may be necessary in obtaining the Architect/Engineer's approval. Only equipment submittals and shop drawings for the installation of systems shall be used at the construction site which have Architect/Engineers stamp of approval. Contractor shall not install any equipment or materials in this contract unless they have been previously approved by the Architect/Engineer. Contractor shall not delay the progress of the work by resorting to unnecessary delays in resubmitting shop drawings or submittals for approval.

I. When they have been rejected or have been returned for additional information, no longer than 3 weeks shall elapse between receipt of returned material and the resubmittal of revised or new information. Architect/Engineer shall have the option of canceling the Contractor's privilege of substituting materials and equipment if there is evidence of flagrant abuse of this equipment.

J. It is suggested that the Contractor obtain from his various equipment suppliers, at the time that shop drawings and submittals are prepared, all of the information that will ultimately be required for the Maintenance and Operating Manual.

1.32 SUBSTITUTIONS:

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

B. Various items of equipment, fixtures, and materials that have been used as the Design Basis for the Plumbing system design, and have been specified by a manufacturer's name and model number. Substitutions of another manufacturer's product must be submitted in accordance with the substitution procedure outlined in the Division 01 specifications at time of bidding. In addition to the requirements of the Div. 01 specifications, substitution requests must contain a line item breakdown of all specified performance materials and requirements of the specified basis of design fixture/equipment. The Architect/Engineer shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each of the Contractor's substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. Contractor shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation. It shall be the responsibility of the Contractor to verify that substitute equipment/fixture, will fit into the designated spaces. Contractor shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing. Refer to Division 01 specifications for additional Substitution requirements.

1.33 ALTERNATES:

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

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

1.34 ALIGNMENT/COORDINATION:

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

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

1.35 NOTICE TO SUBCONTRACTORS:

A. The General Conditions, Special and Supplementary Conditions preceding the General Contract Specifications and all other Contract requirements herein apply in full to the Prime Contracts and/or subcontracts as though inserted here. The Contractor's and subcontractor's attention is called to these sections.

B. No extra compensation will be allowed because of the failure of the Prime Contractors and their subcontractors to be fully acquainted with these Documents.

1.36 FINISHED AND UNFINISHED AREAS:

A. Finished area shall be defined as any space with the walls either tiled, plastered, covered, or painted. Where there are ceilings in finished areas, all piping, conduit, ductwork, etc., shall be concealed above the ceiling unless specifically indicated to be exposed.

B. Unfinished areas shall be defined as any space without a wall finish.

C. Where in doubt as to the classification of a specific space, the Contractor shall check with the architect before roughing.

1.37 RECORD DRAWINGS:

A. During construction, the Contractor shall maintain a record set of installation prints. He shall record on these prints, all deviations from the Contract Drawings in pipe sizing, location, and details.

B. At the completion of the work, the Contractor shall forward these prints to the Architect.

C. Locations of all piping and conduits located underground (either below the building floor slab or outside the building) shall be dimensioned so that their exact location can be determined. These dimensions shall be recorded on a set of prints and shall be forwarded to the Architect.

1.38 OPERATION AND MAINTENANCE INSTRUCTIONS:

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

B. Upon the completion of this project, the Contractor shall deliver to the Architect for approval, an operating and maintenance manual in accordance with Division 01 specification sections.

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

D. The operating manual shall be considered a part of the final inspection and shall be submitted for approval at least 30 days in advance of a request for final inspection. In addition to the requirements of Division 01 specification sections the manual shall include:
   1. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.
   2. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and trouble shooting techniques.
   3. A listing of all items of mechanical and electrical equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.
   4. Copies of all A.S.M.E. pressure vessel certifications, state police approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.

E. All of the materials shall be indexed, arranged categorically and be submitted as indicated in the Division 01 specification sections.

1.39 OSHA STANDARDS:

A. The Contractor's attention is called to his sole responsibility in regards to the Occupational Safety and Health Administration Standards. All construction work shall be performed in strict accordance with these Standards.

B. The permanent installation shall meet the requirements of the OSHA Standards. All purchased equipment shall be designed, manufactured, and trimmed with the necessary accessories to meet or exceed the OSHA requirements. Any field constructed facilities - ladders, platforms, guardrails, safety features, and the like - shall be as recommended in the OSHA Standards.

C. No additional costs shall be charged to the Owner for work required to meet OSHA regulations. Any discrepancy between these Plans and Specifications and the OSHA Standards shall be brought to the attention of the Architect for resolution before the work is commenced.

1.40 PAINTING:

A. Prime contractor shall paint materials used in installation of the work of their contract in all unfinished and exterior areas as specified below.

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

C. Paint all ferrous piping exposed to atmosphere or other corrosive environments with corrosion inhibiting prime coating and one coat enamel paint upon installation.

1.41 CONCRETE PADS:

A. Provide concrete housekeeping pads for all floor mounted plumbing equipment, and dowel into the slab. Provide dowels as directed by Structural Engineer.

B. Provide hook type anchor bolts of proper size and length to suit the equipment. Set bolts in pipe sleeves 1" larger than bolt diameter and half the embedded length of the bolt.

C. Where concrete pads are provided, prepare dimensioned drawings showing exact size and location. Distribute drawings to interested parties as directed by Architect.

1.42 EARTHWORK:

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

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

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

D. Excavation under footings or foundations and deeper than the angle of repose from footings or foundations as determined by the Architect shall be backfilled solidly with 3,000 pound concrete, to such angle of repose and bottom of such footing or foundation.

E. Refer to the plumbing details for additional earthwork requirements.

1.43 CODES, ORDINANCES, AND FEES:

A. Installation of all work shall be done in strict accordance with all applicable local ordinances, local regulations, and state statutes. In case of conflict, the code having immediate jurisdiction shall govern. Methods to be used in the installation of equipment and materials shall not be construed to permit deviation from the requirements of governing Codes.

B. Contractor shall obtain all permits and shall arrange for all inspections that may be required in connection with the work. All fees shall be paid by the Contractor. Work shall be done in accordance with, but not limited to, the applicable sections of the latest edition and supplement to the following codes and Standards:
   1. Building/Plumbing Ordinance as interpreted by the Building/Plumbing Inspector.
   2. Sprinkler Systems; NFPA 13.
   3. National Fuel Gas Code; NFPA 54.
   4. Boilers; NFPA 85.
   5. Chimneys and Vents; NFPA 211.
   6. National Electric Code, NFPA No. 70.
   7. NEMA Standard which pertain to motors, motor starter, control panels and wiring devices that are furnished as an integral part of items of mechanical equipment.

C. It shall be understood that the ANSI Standards and ASTM Specifications that are referred to in this Division are intended to be the current edition of each.

1.44 DEMONSTRATIONS AND SPARE PARTS:

A. The following is a list of equipment and systems that need to be demonstrated to the Owner and his representatives by either the installing Contractor or a factory representative.

B. The Contractor shall coordinate with the Owner the exact day and time the demonstrations will take place. Sufficient notice shall be given, so the Owner may have the proper personnel available to receive the demonstrations. It is strongly recommended the Contractor obtain signatures from those in attendance that they received the demonstrations and instructions. A copy of the O & M shall be on-site during the demonstration. Each demonstration shall be videotaped and the tape shall be turned over to the Owner for future reference.

C. Following is a list of common items requiring demonstration. Demonstrations shall not necessarily by limited to this list.
   1. Date of Demonstration: By:
   2. Plumbing
      a. Water Heater(s)
      b. Mixing Valves
      c. Recirculation Pumps and systems
      d. Grease Interceptors
      e. Plumbing Fixtures & Trim

1.45 CLOSE OUT DOCUMENTS

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

B. Refer to Division 01 for additional close out documentation requirements.

1.46 COMMISSIONING

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

END OF SECTION 22 0100

SECTION 22 0502 - EXCAVATION, BACKFILL & COMPACTION FOR UTILITY TRENCHES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 31 - Earthwork

1.2 SUMMARY

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

1.3 DEFINITIONS

A. Backfill: Stone materials or imported structural fill materials.

B. Bedding Course: Layer placed over the excavated subgrade in a trench before laying a pipe.

C. Utilities: Include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 SUBMITTALS

A. Refer to Division 01 Specifications for submittal procedures

B. Certificates: Submit certification attesting that the composition analysis of pipe embedment and select material stone backfill materials meet specification requirements.

1.5 QUALITY ASSURANCE

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

B. Testing and Inspection Service: Owner shall hire an independent testing and inspection agency to perform all soil testing during earthwork operations.

C. Testing Laboratory Qualifications: To qualify for acceptance, the testing laboratory must demonstrate to Architect's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct required field and laboratory testing without delaying the progress of the work.

D. Testing & Inspection Agency: The Owner will provide and pay for the services of a Independent Testing & Inspection Agency who will have the responsibility of determining what subgrade is acceptable or unacceptable and must be removed by the Contractor. The imported fill or imported structural fill shall be installed and compacted under the direction and observation of the Independent Testing & Inspection Agency. The Independent Testing & Inspection Agency will also document quantities of all materials on a daily basis. The Independent Testing & Inspection Agency will also monitor other earthwork that the Owner determines.

1.6 PROJECT CONDITIONS

A. Excavation and Rock Removal:
   1. General:
      a. The Contractor shall complete the excavation as indicated on the drawings and in Division 01.
      b. When excavation has reached required subgrade elevations, notify Architect or Independent Testing & Inspection Agency, who will make an inspection of conditions. If the Independent Testing & Inspection Agency determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as to the extent directed by the Independent Testing & Inspection Agency.
   2. Excavation Classifications: Refer to Division 01 and Division 31.

B. Compaction of Backfill:

1. Placing of Fill Materials: Place the specified structural fill, stone backfill and in all areas, in layers not more than 6” in loose depth for material compacted by heavy compaction equipment, and not more than 4” in loose depth for material compacted by hand-operated tampers.
2. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.
3. Place imported structural fill, backfill and fill materials evenly adjacent to structures to required elevations. Prevent wedging action of backfill against structured by carrying material uniformly around structure to approximately same elevation in each lift.
4. Compaction: Provide fill compaction to minimum percentage of density specified for each area classification indicated below. Correct improperly compacted area or lifts as directed by Architect or Construction Manager if density tests indicated inadequate compaction.
    a. Percentage of Maximum Density Requirements: Compact to not less than the following percentages of maximum dry density, in accordance with ASTM D 698.
        1) Under concrete building slabs, under concrete foundations and footings, compact each layer of imported structural fill material at 98 percent of maximum dry density. Extend compacted area beyond the exterior face of the building a distance equal to the depth of fill at that area but not less than 10 feet.
        2) Under exterior concrete and asphalt paving compact each layer of backfill or fill material at 98 percent of maximum dry density.
        3) Under lawn or unpaved areas, compact each layer of backfill or fill material at 95 percent of maximum dry density.
        4) At exterior face building foundation walls and walls beyond the exterior of the face of the building, each layer of backfill or fill shall be compacted to 95 percent of maximum dry density.
        5) At asphalt and concrete paving the top 6 to 8 inches of subgrade under the paving and aggregate base course shall be compacted to 98 percent of the maximum dry density. The aggregate base course shall also be compacted to 100 percent of the maximum dry density.

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

1.7 COLD WEATHER PROTECTION

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

PART 2 PRODUCTS

2.1 PIPE BEDDING OR EMBEDMENT MATERIAL

A. Refer to details on drawings.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Layout utility trenchwork and establish extent of excavation by area and elevation. Designate and identify datum elevation and project engineering reference points. Set required lines, levels, and elevations.

B. Notify Architect of unexpected subsurface conditions and discontinue work in area until notified to resume work.

C. Maintain and protect existing utilities identified by utility users within the Work area.

D. Verify that structure walls are braced to support surcharge forces imposed by backfilling operations.

3.2 PROTECTION OF ADJACENT WORK

A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.

B. Grade excavation top perimeter to prevent surface water runoff into excavation or to adjacent properties.

3.3 EXCAVATION

A. Width of Excavation:
   1. Pipelines:
      a. Excavate trenches, including laterals, to a width necessary for placement and jointing of the pipe, and for placing and compacting pipe embedment under, around and over the pipe.
      b. Shape trench walls completely vertical from trench bottom to at least two (2) feet above the top of the pipe.
      c. For pressure pipeline fittings, excavate trenches to a width that will permit placement of concrete thrust blocks. Provide earth surfaces for thrust blocks that are perpendicular to the direction of thrust and are free of loose or soft material.

B. Length of Open Trench:
   1. Do not advance trenching operations more than 200 feet ahead of completed pipeline.

3.4 SUPPORT OF EXCAVATION

A. Support excavations with sheeting, shoring, and bracing or in the case of pipeline construction, a "trench box" as required to comply with State, and local laws and codes.

B. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through negligence or fault of contractor in any other manner, shall be repaired at contractor's expense.

C. Withdraw shoring, bracing, and sheeting as backfilling proceeds unless otherwise directed by the Architect.

D. The neglect, failure or refusal of the Architect to order the use of bracing or sheeting, or a better quality, grade, or section, or larger sizes of steel or timber, or to order sheeting, bracing, struts, or shoring to be left in place, or the giving or failure to give orders or directions as to the manner or methods of placing or driving sheetings, bracing, jacks, wales, stringers, etc., shall not in any way or to any extent relieve Contractor of any responsibility concerning the condition of excavation or of any of his obligations under the Contract, nor shall any delay, whether caused by any action or want of action on the part of Contractor, or by any act of Owner and Architect or their agents, or employees, resulting in the keeping of an excavation open longer than would otherwise have been necessary, relieve contractor from the necessity of properly and adequately protecting the excavation from caving or slipping, nor from any of their obligations under the Contract relating to injury of persons or property, nor entitle them to any claim for extra compensation.

3.5 DEWATERING

A. Keep excavations dry and free of water. Dispose of precipitation and subsurface water clear of the work.

B. Maintain pipe trenches dry until pipe has been jointed, inspected, and backfilled, and concrete work has been completed. Prevent trench water from entering pipelines under construction.

3.6 PIPE LAYING

A. Provide required pipe bedding placed in accordance with the Drawing Details and Specifications.

B. Shape recesses for the joints or bell of the pipe by hand. Assure that the pipe is supported on the lower quadrant for the entire length of the barrel.

C. Lay pipe as specified in the appropriate Section of these Specifications for pipeline construction.

3.7 BACKFILLING EXCAVATIONS

A. Pipeline Trench:
   1. After pipe installation and inspection, provide material to complete the pipe embedment in accordance with the Drawing Details and Specifications.

B. Lift Thickness Limitations:
   1. Lift thicknesses shall be limited to 4 inches for pipe embedment, and 6 inches maximum for pipeline trenches within paved areas and non-paved areas and for structure excavations. In no case shall maximum lift thickness placed exceed the maximum limits specified by the manufacturer's recommendations for the compaction equipment to be utilized. Compaction equipment shall not be used over the pipe until sufficient backfill has been placed to insure that such equipment will not damage or disturb the pipe.

C. Unsuitable Backfill Material:
   1. Where the Independent Testing & Inspection Agency or Architect determines backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with suitable backfill material. Unsuitable material shall be legally disposed of, off-site by the contractor.

3.8 FIELD QUALITY CONTROL

A. Quality Control testing During Construction: Contractor shall coordinate with Owner's testing laboratory to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method) as applicable.
   a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.
   b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.
2. Perform one test at each structure per foot of backfill and one test for each 50 lineal feet of pipe or fractions thereof, per foot of backfill.
3. If in opinion of Architect, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and that have been placed are below specified density, perform additional compaction and that have been placed are below specified density, perform additional compaction and testing until specified density is obtained. trenching and backfilling operations with Independent Testing and Inspection Agency to perform field inspections and tests during trenchwork operations. Laboratory, inspection service, and Independent Testing & Inspection Agency shall be subject to acceptance by the Architect.

3.9 DISPOSAL OF EXCAVATED MATERIAL

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

3.10 CLEANUP

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

END OF SECTION 22 0502

SECTION 22 0516 - 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.

1.2 RELATED REQUIREMENTS

A. Section 22 1005 - Plumbing Piping.

1.3 REFERENCE STANDARDS

A. ASTM A 269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2008.

B. EJMA (STDS) - EJMA Standards; Expansion Joint Manufacturers Association; 2003.

1.4 SUBMITTALS

A. See Section 01 3000 - 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.

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.

1.5 REGULATORY REQUIREMENTS

A. Conform to UL requirements.

1.6 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements, for additional provisions.

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

PART 2 PRODUCTS

2.1 THERMAL EXPANSION LOOPS - COPPER PIPING

A. Manufacturer:
   1. Flexicraft Industries: www.flexicraft.com
   2. Metraflex Company: www.metraflex.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Inner Hose: Bronze.

C. Exterior Sleeve: Braided bronze.

D. (2) two 90° elbows, and (1) 180° return w/drain/air release plug: Bronze

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

F. Joint: Flanged.

G. Size: Use pipe sized units.

H. Offset: As calculated per application. Manufacturer to calculate and verify acceptable offset for corresponding lengths of piping served

I. Installed in neutral position

2.2 EXPANSION LOOPS - SEISMIC/BUILDING EXPANSION JOINTS - COPPER PIPING

A. Manufacturer:
   1. Flexicraft Industries: www.flexicraft.com
   2. Metraflex Company: www.metraflex.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Inner Hose: Bronze.

C. Exterior Sleeve: Braided bronze.

D. (2) two 90° elbows, and (1) 180° return w/drain/air release plug: Bronze

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

F. Joint: Flanged.

G. Size: Use pipe sized units.

H. Installed in neutral position. Provide Seismic bracing as determined by seismic engineer

2.3 EXPANSION LOOPS - SEISMIC/BUILDING EXPANSION JOINTS - STEEL PIPING

A. Manufacturer:
   1. Flexicraft Industries: www.flexicraft.com
   2. Metraflex Company: www.metraflex.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Inner Hose: Stainless Steel.

C. Exterior Sleeve: Braided Stainless Steel.

D. (2) two 90° elbows, and (1) 180° return w/drain/air release plug: Stainless Steel

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

F. Joint: Flanged.

G. Size: Use pipe sized units.

H. Installed in neutral position. Provide Seismic bracing as determined by seismic engineer

2.4 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. Manufacturers:
   1. Flexicraft Industries: www.flexicraft.com
   2. Metraflex Company: www.metraflex.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Inner Hose: Stainless Steel.

C. Exterior Sleeve: Single braided, stainless steel.

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

E. Joint: Threaded.

F. Size: Use pipe sized units.

G. Maximum offset: 1 inch on each side of installed center line.

2.5 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturer:
   1. Flexicraft Industries: www.mercer-rubber.com.
   2. Metraflex Company: www.metraflex.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

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: 1 inch on each side of installed center line.

H. Application: Copper piping.

2.6 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. Refer to Plumbing details for additional requirements.

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. 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.

E. 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.

F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Provide Thermal Expansion fittings on all hot and hotwater return piping segments exceeding 50 ft. in lengths and at intervals not to exceed 100ft. Manufacturer of expansion fittings shall provide calculations to verify suitability for individual applications.

G. All expansion fittings for natural gas service, shall be A.G.A. certified.

H. Provide seismic restraints in conjunction with seismically designed flexible connectors at all locations where piping crosses building seismic expansion joints.

I. Provide nested loops where required by available space.

END OF SECTION 22 0516

SECTION 22 0519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure gages and pressure gage taps.

B. Thermometers and thermometer wells.

1.2 RELATED REQUIREMENTS

A. Section 22 0100 - General Provisions

1.3 REFERENCE STANDARDS

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

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

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

D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

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

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

1.5 FIELD CONDITIONS

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

1.6 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements. for additional provisions.

B. Supply two spare gauges of each type and pressure range installed.

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

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:
   1. Dwyer Instruments, Inc: www.dwyer-inst.com.
   2. Moeller Instrument Co., Inc: www.moellerinstrument.com.
   3. H.O. Trerice: www.trerice.com
   4. Omega Engineering, Inc: www.omega.com.
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background. Pressure gauges installed in domestic water piping shall conform with the Lead free requirements of the Safe Water Drinking Act and NSF-372.
   1. Case: Cast aluminum with phosphor bronze bourdon tube.
   2. Size: 4-1/2 inch diameter.
   3. Size: 2 inch diameter.
   4. Mid-Scale Accuracy: One percent.
   5. Scale: Psi.
   6. Basis of Design: H.O. Trerice Model 620B

2.2 PRESSURE GAGE TAPPINGS

A. Isolation valve: provide gage tapping valve
   1. Gage Cock: Tee or lever handle, brass for maximum 150 psi.

B. Pressure Snubber
   1. Lead Free Brass, NSF-61 compliant, connection size to match gauge connection

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc: www.dwyer-inst.com.
   2. Omega Engineering, Inc: www.omega.com.
   3. H.O. Trerice: www.trerice.com
   4. Weksler Glass Thermometer Corp: www.wekslerglass.com.
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E 1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane. Thermometers installed in domestic water piping shall conform with the Lead free requirements of the Safe Water Drinking Act and NSF-372.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Stem: 3/4 inch NPT brass.
   4. Accuracy: 2 percent, per ASTM E 77.
   5. Calibration: Degrees F.
   6. Basis of Design: H.O. Trerice Model BX9-403

2.4 PORTABLE TEST KIT/PLUGS

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

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

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

D. Provide pressure gauge at each water service entrance riser.

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

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

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

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

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

J. Locate test plugs adjacent thermometers and thermometer sockets.

3.2 SCHEDULES

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

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

END OF SECTION 22 0519

SECTION 22 0548 - VIBRATION ISOLATION & SEISMIC MOUNTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Seismic Restraint & Mountings

B. Vibration Isolation

1.2 SUMMARY

A. The extent of vibration isolation and seismic mounting work is indicated by Drawings and schedules and by requirements of this Section.

B. The types of vibration isolation and seismic mounting work specified in this Section include the following:
   1. Support and vibration isolation and restraints for motor driven equipment.
   2. Support and vibration isolation and restraints for equipment, piping and piping risers.
   3. Flexible connections for piping at vibration isolated equipment.
   4. Seismic support isolation and restraints for equipment, piping and piping risers.

1.3 SUBMITTALS

A. Refer to Division 01 Specifications for Submittal Procedures.

B. The Manufacturer of vibration isolation and seismic restraints 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 and seismic restraints.

C. 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.
   1. Calculated static load on each isolator.
   2. Calculated deflection for each piece of isolated equipment.
   3. Calculated seismic loads, for each restraint including horizontal and vertical forces and overturning moments.

D. Submittals for mountings and hangers incorporating springs shall include spring diameters, rated deflections, spring free height, solid spring height and spring color code.

E. 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.

F. Submittals shall include seismic calculations signed and checked by qualified licensed Engineers in the employ of the Manufacturer of the vibration isolators. Catalog cut sheets shall be included for each type of mounting used on equipment being isolated.
   1. Manufacturer's certification of components seismic acceleration operational capacity and attachment.

1.4 QUALITY ASSURANCE

A. Product Qualification: Provide each type of vibration isolation and seismic mounting 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 and restraints produced by him, and of associated inertia bases.

D. 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.

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.

F. The Contractor shall employ the services of a licensed Professional Engineer registered in the Commonwealth of Pennsylvania to design, submit, and supervise the installation of seismic restraining and mountings products applicable to all equipment and piping systems installed by the Contractor.

G. Submit detailed seismic drawings, drawn to the scale indicated, for each of the following installations. All seismic drawings shall be based on the Architectural and Structural Contract Drawings. All seismic drawings shall bear the stamp of a Professional Engineer licensed in the state of the Project site:
   1. Mechanical Equipment rooms depicting size and location of concrete housekeeping pads and the location and type of seismic restraints. Minimum Scale: 1/4"=1'-0".
   2. Piping Plans depicting location and type of seismic restraints. Minimum Scale: 1/8"=1'-0".
   3. Concrete pad details depicting location and size of reinforcing, doweling, and anchor bolts for each specific piece of equipment. Minimum Scale: 1/2"=1'-0".
   4. Suspended equipment depicting restraint locations, types, and methods of attachment. Minimum Scale: 1/8"=1'-0".
   5. Miscellaneous Attachment Details depicting size, locations, and types of attachment (i.e., bolts, welds, anchors, cables) for securing equipment to seismic mountings and for securing seismic mountings to the building structure.

H. Submit a seismic design errors and omissions insurance certificate. (Manufacturers product liability insurance certificates are not acceptable.

1.5 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 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.

1.6 DESIGN - SEISMIC RESTRAINTS

A. The site is classified as follows: Design Category "B"; International Building Code 2015 and ASCE 7-10 Table 11.6-1 & Pg. 56.

B. Seismic restraint shall be required for the following plumbing system installations:
   1. *(Seismic Design Category B)* None

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise specified, all hardware shall be stainless steel or zinc plated. Springs with a deflection of up to 2 inches shall be zinc plated, or coated with a polyester epoxy powder. Springs with a rated deflection capability greater than 2 inches may be painted. Zinc plating shall conform to ASTM B633, CLASS 2 SC2, minimum.

2.2 TYPE 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.

2.3 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.

2.4 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.

2.5 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.

2.6 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.

2.7 TYPE 13 - FLEXIBLE CONNECTORS

A. Install Quiet-Sphere Flexible Connectors at the suction and discharge of each pump. 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 VMS, VMT, or VMU as manufactured by Vibration Mountings & Controls, Inc.

2.8 TYPE 16 - CABLE RESTRAINTS

A. Steel aircraft cable restraints are designed and installed to limit motion on suspended isolated equipment, piping or ducting. Cables are installed with enough slack to engage only when 1/4 movement occurs. On suspended equipment, cables are installed in sets of four, located at 45 degree angles to all three axes. Where required at pipe hangers, cables are placed two at each location, alternating orientation at successive locations.

B. Cables shall be 7 x 19 galvanized or stainless steel aircraft cable conforming to FED-STD-RR-W-410D. Cable diameters shall be available in at least three sizes to provide cost effective method of support for a wide range of supported loads.

C. Seismic cable restraints shall be Series SCR as manufactured by Vibration Mountings & Controls, Inc.

2.9 TYPE 17 - ELASTOMER MOUNTINGS

A. Consists of a captive elastomeric mount molded from neoprene or EPDM compound conforming to the requirements of ASTM D2000. Load bearing elastomer element shall be housed in either a heat treated cast aluminum housing or machined structural plate.

B. Mount shall incorporate a fail-safe captive design, and shall provide a vertical natural frequency of 15 Hz to 25 Hz, depending upon the static load. Mount shall be capable of providing dynamic deflections of up to .12 inches.

C. Use Vibration Mountings & Controls Series RB1, RB3 or RB4 with structural plate or MB1 or MB3 (aluminum housing).

PART 3 - EXECUTION

3.1 PERFORMANCE OF VIBRATION ISOLATORS AND SEISMIC RESTRAINTS

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

B. The seismic engineer shall supervise and review the installation of all seismic restraints.

3.2 APPLICATIONS

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

B. Vibration Isolation
   1. Provide vibration isolation on each side of pumps and inline motor driven equipment.

3.3 INSTALLATION

A. Isolation and seismic restraint 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.

3.4 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. Passage of piping which is to be isolated through walls and floors.
   4. Do not start up Equipment until inadequacies have been corrected in a manner acceptable to vibration isolation installer.

3.5 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.

3.6 VIBRATION ELIMINATION

A. Vibration isolation supports shall be supplied for all moving or rotating equipment. Supports by Vibration Mountings and Controls, Inc. or approved in advance equal, installed in accordance with manufacturer's recommendations, shall be used unless specified otherwise herein.

B. Rotating or moving machinery or equipment suspended from building structure shall be provided with approved resilient type suspension mounting with lock washer and double nuts.

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

3.7 SOUND ISOLATION

A. All Equipment and piping shall be installed so that no noise or vibration is transmitted to any part of the building beyond the room or rooms in which such noise or vibration is generating. Moving equipment shall be isolated from the concrete foundations or floors by cork where required to prevent transmission of noise of vibration.

B. Silencers shall be installed in water connections to quick closing devices. Shock absorbers shall be used in all pipe lines where required to eliminate noise.

C. Any and all other insulation or isolation required to accomplish the results specified above shall be furnished and installed without additional cost to the Owner.

END OF SECTION 22 0548

SECTION 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.2 REFERENCE STANDARDS

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

1.3 SUBMITTALS

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

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

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

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

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

PART 2 - PRODUCTS

2.1 GENERAL

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

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

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

2.2 NAMEPLATES

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

2.3 VALVE TAGS

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

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

C. Valve Schedule: Provide valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
   1. Frame: For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB grade sheet glass.

2.4 PIPE MARKERS

A. Comply with ASME A13.1.

B. Plastic Pipe Markers: Provide manufacturer's standard pre printed, flexible or semi rigid, permanent, color coded, plastic sheet pipe markers, complying with ANSI A13.1. Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
   1. All Piping: Provide snap-on application of pre-tensioned semi-rigid plastic full-bank pipe markers, extending 360 degrees around pipe at each location.
   2. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
   3. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastics.

2.5 UNDERGROUND PLASTIC PIPE MARKERS:

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

2.6 CEILING TACKS

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

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

B. Valve Identification:
   1. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
   2. Mount valve schedule frames and schedules in machine rooms where indicated or, of not otherwise indicated, where directed by Architect/Engineer.
   3. Provide valve finder ceiling dots at all concealed valve locations. Locate on ceiling grid not on ceiling tile.

C. Mechanical Equipment Identification:
   1. General: Install engraved plastic laminate nameplate on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
      a. Main control and operating valves, including safety devices and hazardous units such as gas pressure regulators.
      b. Tanks and pressure vessels.
      c. Domestic water heaters
      d. Domestic water pressure booster pumps
      e. Recirculation pumps
      f. Water Softeners
      g. Sewage and Stormwater ejectors

END OF SECTION 22 0553

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SECTION 22 0719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

1.2 RELATED SECTIONS

A. Section 078400 - Firestopping.

B. Section 099000 - Painting and Coating: Painting insulation jacket.

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

1.3 REFERENCES

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

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

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

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

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

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

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

H. 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 specifications for submittal procedures.

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

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

1.5 QUALITY ASSURANCE

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

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

1.6 DELIVERY, STORAGE, AND PROTECTION

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

1.7 ENVIRONMENTAL REQUIREMENTS

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

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

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

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

2.2 GLASS FIBER

A. Manufacturers:
   1. Knauf Fiber Glass: www.knaufusa.com.
   2. Johns Manville Corporation: www.jm.com.
   3. Owens Corning Corp: www.owenscorning.com.
   4. CertainTeed Corporation: www.certainteed.com.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible.
   1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 850 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.

C. Insulation: ASTM C 547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 650 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Vapor Barrier Lap Adhesive:
   1. Compatible with insulation.

G. Insulating Cement/Mastic:
   1. ASTM C 195; hydraulic setting on mineral wool.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Armacell International: www.armacell.com.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Type I, Tubular Grade 1; ASTM E 84/ UL 723 25/50 rated for use in return air plenums, use molded tubular material wherever possible. ArmaFlex Ultra or approved equal.
   1. Thermal Conductivity: 0.27 Btu-in/hr-ft2-degF @ 75 deg.F Mean Temp
   2. Minimum Service Temperature: -40 degrees F.
   3. Maximum Service Temperature: 220 degrees F.
   4. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 PLENUM INSULATION

A. Manufacturer
   1. Unifrax Corporation
   2. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: Fyrewrap .5 plenum insulation, high temperature, biosoluble insulation, aluminum foil/fiberglass reinforced scrim encapsulated

2.5 JACKETS/SHIELDS

A. PVC Plastic.
   1. Manufacturers:
      a. Johns Manville Corporation: www.jm.com.
      b. Substitutions: See Section 016000 - Product Requirements.
   2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
      d. Thickness: 10 mil.
      e. Connections: Brush on welding adhesive.

B. Stainless Steel Jackets
   1. Standards:
      a. ASTM-A240 and A666 Standards
   2. Thickness
      a. .016” (.4mm)

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

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

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

E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

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

G. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

H. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.

J. Exposed Insulated Pipe (from floor penetration to 10 feet above finished floor): Provide with Stainless Steel jacket around entire pipe/insulation circumference

K. Provide UL listed plenum insulation on all piping not conforming to the 25/50 smoke and flame requirements for combustibility as required by the International Mechanical code, and installed within return air plenum spaces.

3.3 SCHEDULES

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

END OF SECTION 22 0719

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SECTION 22 1005 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe, Pipe Fittings, Pipe Hangers and Supports, Valves, and Miscellaneous connections for piping systems.
   1. Waste/Sanitary Sewer & Vent.
      a. Contractor shall provide complete Sanitary drainage and vent piping system as shown on plumbing drawings and specified herein including but not limited to all: piping, pipe fittings, pipe supports, pipe anchors, drains, and equipment/fixture connections including final coordination and connection to Site Sanitary system.
   2. Domestic Potable Water.
      a. Contractor shall provide complete Domestic Cold, Hot, and Hot Water Return, & Tempered water piping systems as shown on plumbing drawings and specified herein including but not limited to all: equipment, piping, valves, fittings, supports, anchors, insulation, connections to equipment/fixtures and plumbing specialties including final coordination and connection to Site Water supply.
   3. Condensate Drain Piping
      a. Contractor shall provide complete condensate drainage 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 t including final connection to Site Storm water system or discharge point as noted on the drawings.
   4. Compressed Air
      a. Contractor shall provide complete Compressed Air piping system as shown on plumbing drawings and specified herein including but not limited to all: equipment, piping, pipe fittings, pipe supports, and pipe anchors.
   5. Lube Oil and Grease distibution
      a. Contractor shall provide complete Lube Oil and Grease distribution system as shown on plumbing drawings and specified herein including but not limited to all: equipment, piping, pipe fittings, pipe supports, and pipe anchors.

1.2 RELATED REQUIREMENTS

A. Section 07 8413 - Penetration Fireproofing

B. Section 08 3100 - Access Doors and Panels.

C. Section 09 9000 - Painting and Coating.

D. Section 22 0100 - General Provisions

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

F. Section 22 0548 - Vibration Isolation and Seismic Mountings.

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

H. Section 22 0719 - Plumbing Piping Insulation.

I. Section 22 1006 - Plumbing Piping Specialties

1.3 REFERENCE STANDARDS

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

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

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

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

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

E. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

U. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association; 2005 (ANSI/AWWA C105/A21.5).

V. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2009 (ANSI/AWWA C151/A21.51).

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

X. 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.

Y. 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.

Z. IBC2015 - ICC - International Building Code; 2015

AA. IPC2015 - ICC - International Plumbing Code; 2015

AB. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

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

AD. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2008.

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

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

1.4 SUBMITTALS

A. In addition to the requirements of Division 01 specifications, plumbing product submittals shall be in accordance with the following:
   1. Piping & Pipe fitting Product Data: Provide manufacturer's data on pipe materials and pipe fittings specified herein. Submittals shall clearly indicate exact materials to be provided and applications where the submitted product is to be installed and associated specification section. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
   2. Hangers & Supports, Valve, & Misc. Product Data: Provide manufacturer's data for Hangers & supports, valve, & miscellaneous piping products specified herein. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
   3. Project Record Documents: Record actual locations of valves. Provide valve schedule as required in Section 22 0553 "Identification for Plumbing Piping and Equipment".
   4. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data in Maintenance Manual.
   5. Maintenance Materials: Furnish the following for Owners use in maintenance of project.
      a. See Section 01 6000 - Product Requirements, for additional provisions.
      b. Valve Repacking Kits: One for each type and size of valve.

B. Review of submittals which do not clearly indicate the information noted below may be delayed or Rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review. P.C. is responsible to review plumbing product submittals provided by suppliers and coordinate and verify all submittal information prior to submission to Architect/Engineer.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Pennsylvania, UCC standards.
   1. Maintain one copy on project site.

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

C. Piping
   1. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
   2. Welder Qualifications: Certified in accordance with ASME (BPV IX) or ANSI 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 UCC building codes including but not limited to IPC, IFGC, IBC, and IFC (Latest editions).

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

C. Submit product data for backflow prevention devices, service valving, and meters to the Municipal Water Authority prior to submission to Architect/Engineer. Obtain approval for devices and installation details and submit written approval with product data submittal to Architect/Engineer.

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

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

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

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

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

1.8 FIELD CONDITIONS

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

1.9 EXTRA MATERIALS

A. See Section 01 6000 - Project Requirements, for additional provisions.

B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

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

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

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

A. PVC Pipe: Schedule 40 ASTM D 2665 or ASTM D 3034. (No foam core permitted) - PVC Piping option for Sanitary Sewer and Waste piping systems shall not be permitted in areas with high temperature drainage discharge, these areas include but are not limited to: Kitchens, Boiler/Mechanical Rooms, etc. In areas with high temperature drainage discharge, Cast Iron Pipe shall be used in lieu of PVC piping. This cast iron pipe shall extend beyond the affected room/space to a minimum of 10ft. beyond the most downstream high temperature drain connection.
   1. Manufacturers:
      a. Charlotte Pipe and Foundry
   2. Fittings: PVC (DWV Pattern).
   3. Joints: Solvent welded, with ASTM D 2564 solvent cement.

2.3 WASTE & VENT PIPING, ABOVE SLAB/GRADE

A. Cast Iron Pipe: CISPI 301, hubless.
   1. Manufacturers:
      a. Charlotte Pipe and Foundry
      b. Tyler Pipe
   2. Fittings: Cast iron.
   3. Joints: Heavy Duty Couplings: ASTM C 1540/ASTM C 564/FM 1680 Class 1, neoprene gaskets and smooth 304 stainless steel clamp-and-shield assemblies with .010in minimum thickness corrugated shield, four clamps for sizes 1-1/2"-4", six clamps for sizes 5"-10", and worm gear drive clamps torqued to 80 inch pounds.

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

A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
   1. Fittings: Provide fittings from one of the options below. All fittings/components within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%) and other equivalent state regulations
      a. Soldered Fittings (all pipe sizes): ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
      b. Copper Press Fittings (all pipe sizes): Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements. fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Copper press fittings shall be manufactured by Viega and installed utilizing Rigid Tool Company as "Pro Press System" or equal system as approved by Engineer. Complete installation shall comply with manufacturers recommendations.
   2. Joints: Provide pipe joints from one of the options below.
      a. Solder Joints(All Sizes): ASTM B32, alloy Sn95 solder.
      b. Press Fit Joints(All Sizes): ProPress (as specified above)
   3. Unions (Pipe Sizes 2" and Under):
      a. Copper tube and pipe: Class 150 bronze unions with soldered joints.
   4. Flanges (Pipe Size Over 1 Inch):
      a. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

2.5 DOMESTIC POTABLE AND NON-POTABLE WATER SERVICE PIPING BURIED BELOW SLAB/GRADE

A. Copper Tube (2 in. and smaller): ASTM B 88 (ASTM B 88M), Type K (A).
   1. Fittings: No fittings permitted below grade
   2. Joints: Flared

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

2.6 DOMESTIC POTABLE AND NON-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

2.7 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.

2.8 CONDENSATE DRAIN PIPING, ABOVE SLAB

A. Copper Pipe: Type DWV with soldered joints and fittings.

2.9 LUBE OIL AND GREASE DISTRIBUTION PIPING

2.10 FLANGES, UNIONS, AND COUPLINGS

A. Unions (Pipe Sizes 2" and Under):
   1. Ferrous pipe: Class 150 malleable iron threaded unions.
   2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

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

C. Dielectric Unions/Connections: Provide standard products recommended by manufacturer for use in service indicated which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
   1. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier
   2. Manufacturer: Subject to compliance with requirements, provide dielectric unions of one of the following:
      a. Atlas Products Co.
      b. Capital Mfg. Co., Div. of Harsco Corp.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. PSI Industries.
      f. Stockham Valves and Fittings.

2.11 MISCELLANEOUS PIPING FABRICATION MATERIALS:

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

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

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

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

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

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

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

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

2.12 PIPE HANGERS AND SUPPORTS

A. HORIZONTAL PIPING HANGERS AND SUPPORTS:

1. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information: size hangers and supports properly for piping including insulation, for insulated piping systems..
   a. Adjustable Clevis Hangers: MSS-SP-69 Type 1, fabricated from steel. (Insulated or Non-insulated - Stationary piping systems)
   b. Adjustable Swivel Band Hangers: MSS-SP-69 Type 10 fabricated from steel. (Non-insulated - Stationary piping systems)
   c. Adjustable Roller Hangers: MSS-SP-69 Type 43, including axle roller and clevis.(Insulated or Non-insulated - Non-Stationary piping systems)
   d. Steel Brackets: Welded structural steel shapes complying with one of the following:
      1) Light Duty: MSS Type 31.
      2) Medium Duty: MSS Type 32.
      3) Heavy Duty: MSS Type 33.

B. VERTICAL PIPING CLAMPS:

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

C. HANGER ROD ATTACHMENTS:

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

D. BUILDING ATTACHMENTS:

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

E. SADDLES AND SHIELDS:

1. General: Except as otherwise indicated, provide factory fabricated saddles and shields of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size saddles and shields properly for insulation and vapor barriers (if any).
   a. Protection Saddles: MSS-SP-69 Type 39.
   b. Protection Shields: MSS-SP-69 Type 40.
   c. Wood Insulation Saddle: Provide products manufactured by Elcen Metal Products Company.

F. RESTRAINTS

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

G. MISCELLANEOUS HANGER AND SUPPORT MATERIALS:
1. Metal Framing: Provide products complying with NEMA STD ML 1. Contractor shall provide all miscellaneous steel required for support of work within his contract.
2. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
3. Cement Grout: Portland cement (ASTM C 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 a two sections guiding spider bolted tightly to the pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of the length recommended by the manufacturer to allow indicated travel.

2.13 VALVES:

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

B. All valves and specialties within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%), NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372, and other equivalent state regulations.

C. All shutoff valves 4" and smaller within the domestic potable water piping shall be full port ball valve type unless noted otherwise.

D. BALL VALVES:
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
   a. Conbraco Industries, Inc.
   b. Milwaukee Valve Co., Inc.
   c. NIBCO, Inc.
2. General: Valves shall be rated 600 PSI non-shock CWP, valve ends shall have full depth ANSI threads, Press fit, or extended solder connections.
3. Comply with the following standards: MSS SP-110
4. Domestic Water Service: Valves shall be rated 600 PSI non-shock CWP and will have 2-pc. lead-free * dezincification-resistant bronze body, end piece, stainless steel stem and ball, PTFE seats, full port, separate pack nut with adjustable stem packing, anti-blowout stems and have the capability of accepting extended operating handles. Valve ends shall have full depth ANSI threads or extended solder connections. Valves shall be 3rd party certified to NSF/ANSI-61-8Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372. Valves for use in insulated piping systems shall be equipped with 2" extended handles of non-thermal conductive material. A protective sleeve shall allow operation of the valve without disturbing the installation and providing a vapor seal. Product shall be NIBCO NIB-SEAL or approved equal.
   a. Basis of Design(threaded ends): NIBCO T585HP-66-LF (1/2" to 3")
   b. Basis of Design(Soldered): NIBCO S585HP-66-LF (1/2" to 3")
   c. Basis of Design(PressFit): NIBCO PC-585HP-66-LF (1/2" to 3")

E. MANUAL BALANCING VALVES
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
   a. Conbraco Industries, Inc.
   b. Milwaukee Valve Co., Inc.
   c. NIBCO, Inc.
2. Domestic Hot Water Service: Return branch balancing valves ½ " to 2" shall be Globe Style, . Valve shall have integral metering/test ports for flow balancing and flow measurement. Test ports shall have internal check valve and be equipped with caps. Valves shall be manufactured from lead free dezincification resistant brass or bronze rated 240 psi at 250 F. All balancing valves shall have position indication readout and built in memory stop for repeatable regulation and control.
   a. Basis of Design: NIBCO ® Series 1810-LF

F. CIRCUIT SETTER BALANCING VALVES
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
   a. Bell & Gosset
2. Domestic Hot Water Service: Circuit Balancing Valves ½ " to 2" shall be Lead Free ball valve style. Valve shall have integral metering/test ports for flow balancing and flow measurement and be able to be pre-set to appropriate flow. Test ports shall have internal check valve and be equipped with caps. Valves shall be manufactured from dezincification resistant brass or bronze rated 240 psi at 250 F. All circuit balancing valves shall have calibrated nameplates with position indication readout and built in memory stop for repeatable regulation and control and designed for positive shutoff.
   a. Basis of Design: Bell & Gosset ® CB - LF Series

G. SWING CHECK VALVES:
1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
   a. Conbraco Industries, Inc.
   b. Milwaukee Valve Co., Inc.
   c. NIBCO, Inc.
2. Comply with MSS SP-71 and MSS SP-SO for design, workmanship, material and testing.
3. For Domestic Water Service: Valves shall be Y-pattern swing-type rated 200 PSI non-shock CWP. Body, bonnet, and disc hanger are to be of lead-free dezincification-resistant material and PTFE seat disc. Valve ends may be threaded or solder-type. Valves shall be 3rd party certified to NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372.
   a. Basis of Design: NIBCO ® T413-Y-LF (threaded); S413-Y-LF (solder)

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

2.14 LOW PRESSURE Y-TYPE STRAINERS:

A. Manufacturer: Subject to compliance with requirements, provide low pressure Y-Type strainers of one of the following:
1. Armstrong Machine Works.
2. Hoffman Specialty, ITT Fluid Handling Div.
3. Metraflex Co.
4. Crane Co., Valve Div.
5. Milwaukee Valve Co., Inc.
6. NIBCO, Inc-

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

C. All valves and specialties within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%) and other equivalent state regulations
   1. Threaded Ends: 2" and Smaller: Lead Free Bronze body rated for 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with threaded ball valve and pipe plug.
   2. Threaded Ends: Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with threaded ball valve and pipe plug.
   3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with threaded ball valve and pipe plug.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

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

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

3.3 INSTALLATION

A. PIPING INSTALLATION:

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

6. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. 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. Solder copper tube and fittings joints in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
8. Weld pipe joints in accordance with ANSI B31.
9. Flanged Joints: Match flanged within piping systems, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
10. Insulating Unions: Comply with manufacturer's instructions for installing unions. Install unions in a manner which will prevent galvanic action and stop corrosion when joining ferrous and non-ferrous piping.
11. Grooved Joints: Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to grooved. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the job site and review and installation. Contractor shall remove and replace any joints deemed improperly installed.
12. Unless noted otherwise on the Plumbing drawings all Sanitary/Waste, Kitchen Sanitary/Kitchen Waste, Rainwater, Emergency Rainwater, and Storm piping shall be installed at a minimum continuous 2% slope (1/4" per foot).
13. Unless noted otherwise on the Plumbing drawings all Vent, Condensate Drainage, and Radon Remediation piping shall be installed at a minimum continuous 1% slope (1/8" per foot).
14. Provide penetration firestopping for all work of Div. 22 in accordance with Div. 07 specifications.

B. PIPING INSPECTION:
1. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings if any. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
2. Disinfect water service piping in accordance with IPC or as required otherwise by local AHJ. Perform bacterialogical and chemical contaminant testing in accordance with IPCand submit test results to Engineer and local AHJ.

C. PIPING TESTS:
1. General: Provide temporary equipment for testing, including pumps and gages. Test piping system before insulation is installed wherever feasible and remove control devices before testing.
2. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
3. Test piping installations and backflow preventers in accordance with IPC Section 312. Coordinate testing with local AHJ.
4. Repair piping systems sections which fail the required piping tests by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.

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

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

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

G. HANGERS AND SUPPORTS INSTALLATION:

1. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire 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.

H. PIPE GUIDE INSTALLATION:

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

I. PIPING ANCHORS INSTALLATION:

1. Install anchors at the proper location to prevent stresses from exceeding those permitted by ANSI 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.

J. ADJUSTMENT OF HANGERS AND SUPPORTS:

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

K. VALVE INSTALLATION:

1. General: Except as otherwise indicated, comply with the following requirements:
   a. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   b. Install valves with stems pointed up, in the vertical position, where possible, but in no case with stems pointed downward from a horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
   c. Insulation: Where insulation is indicated, install extended stem valves, arranged in the proper manner 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.

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

M. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

N. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

O. Install piping to maintain headroom, conserve space, and not interfere with use of space.

P. Group piping whenever practical at common elevations.

Q. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.

R. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.

S. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.

T. Establish elevations of buried piping outside the building to ensure not less than four ft of cover.

U. Install vent piping penetrating roofed areas to maintain integrity of roof assembly. Coordinate all requirements with roof installer. Install vent piping penetrations in existing roof assemblies in accordance with all requirements of the roof manufacturer to maintain existing roof warranty.

V. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

W. Provide support for utility meters in accordance with requirements of utility companies.

X. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 9000.

Y. Install bell and spigot pipe with bell end upstream.

Z. Install valves with stems upright or horizontal, not inverted.

AA. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.

AB. Install water piping to ASME B31.9 and IPC requirements.

AC. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.

AD. Sleeve pipes passing through partitions, walls and floors.

3.4 APPLICATION

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

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

C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Provide spring loaded check valves on discharge of water pumps.

E. Provide plug valves in natural gas systems for shut-off service in piping systems larger than 2".

F. Provide ball valves with lever handles in natural gas systems for equipment shutoff valves.

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

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with IPC

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

C. 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).

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

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

F. Maintain disinfectant in system for 24 hours.

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

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

I. 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.

3.6 SERVICE CONNECTIONS

A. Provide new sanitary and storm sewer connections as noted on plans. Before commencing any work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and minimum cover as required by AHJ.

B. Provide new domestic water service complete with approved backflow preventer and pressure reducing valves. Provide water service entrance piping installations in accordance with all requirements of local municipal Water Authority.

END OF SECTION 22 1005

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SECTION 22 1006 - PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Automatic Clothes Washing Machine Connection

B. Backflow preventers.

C. Cleanouts.

D. Floor drains.

E. Hose bibbs.

F. Hydrants.

G. Pressure reducing valves

H. Shock Absorbers/Water hammer arrestors.

I. Thermostatic mixing valves.

J. Trench Drains

K. Washdown Boxes

1.2 RELATED REQUIREMENTS

A. Section 22 0100 - General Provisions

B. Section 22 1005 - Plumbing Piping.

C. Section 22 3000 - Plumbing Equipment.

D. Section 22 4000 - Plumbing Fixtures.

1.3 REFERENCE STANDARDS

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

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

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

D. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent; American Society of Sanitary Engineering; 2009 (ANSI/ASSE 1012).

E. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011

F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011

G. IBC2015 - ICC - International Building Code; 2015

H. IPC2015 - ICC - International Plumbing Code; 2015

I. IFGC2015 - ICC - International Fuel Gas Code; 2015

J. NSF 61 - Drinking Water System Components - Health Effects; 2014 (Errata 2015)

K. NSF 372 - Drinking Water System Components - Lead Content; 2011

L. PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute; 2006.

1.4 SUBMITTALS

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

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

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

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

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

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

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

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements, for additional provisions.

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

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

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

2.2 AUTOMATIC CLOTHES WASHING MACHINE CONNECTION

A. Box Manufacturers:
   1. Guy Gray Corporation:
   2. IPS Corporation/Water-Tite: www.ipscorp.com.
   3. Oatey: www.oatey.com.
   4. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (ACW-1) Washing Machine Connection Box w/Water Hammer Arrestors and Preformed Drain Outlet
   1. PVC preformed rough-in box with brass valves with single lever handle and water hammer arrestors, socket for 2 inch waste, slip in finishing cover.
   2. Basis of Design: IPS Watertite 85708

2.3 BACKFLOW PREVENTERS

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

B. Service Entrance - Reduced Pressure Zone Backflow Preventers (2-1/2"-10"):
   1. ASSE 1013; FDA epoxy coated cast iron body with stainless steel 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 OS&Y gate valves, strainer, air gap fitting, and four test cocks.
      a. Watts Model LF909- OSY/S-FDA (2-1/2"-10") w/series 909AG air gap fitting or approved equal.

C. Reduced Pressure Zone Backflow Preventers (3/4"-2"): Boiler makeup water, mechanical equipment, and irrigation water connections, etc.
   1. ASSE 1013; Lead free, cast copper/bronze body with bronze internal parts and stainless steel check 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, and four test cocks.
      a. Watts Model LF909-QT-S (3/4"-1") w/series 909AG air gap fitting or approved equal
      b. Watts Model LF909-M1-QT-S (1¼"-2") w/series 909AG air gap fitting or approved equal

D. Double Check Backflow Preventers (1/4"-2"):
   1. ASSE 1015; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; assembled with two quarter turn ball valves, strainer, and four test cocks.
      a. Watts Model S-QT-LF007 or approved equal

2.4 CLEANOUTS

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

B. (CTG) Cleanouts to Grade (exterior areas):
   1. Round, flanged cast iron housing and heavy duty scoriated cast iron cover.
   2. Refer to plans for locations and details of installation.
   3. Basis of design J.R. Smith Model 4250/4261 series with top finish as required by Architect:
      a. Outlet Connection style/type to be detrimined by contractor.

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

D. (FCO) Cleanouts at Garage,Mechanical Room Floor Areas:
   1. Lacquered cast iron body with anchor flange, threaded ABS plug assembly, and round Nickel Bronze cover. Cover shall be scoriated in service areas.
   2. Basis of design: J.R. Smith Model 4100/4111/4105 series (Outlet connection type as determined by P.C)

E. (WCO)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

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

2.5 FLOOR DRAINS

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

B. (FD-1) Floor Drain - General area floor drains, toilet rooms, showers, etc.:
   1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, twist-to-floor adjustable 5" round nickel bronze strainer.
      a. Deep seal P-trap
      b. Pro-Set "trap-guard" sewer gas prevention system.
      c. Sediment bucket option in all shower floor drain
   2. Refer to drawings for locations and system sizes.
   3. Basis of Design:
      a. J.R. Smith: Model 2005-NB with 5" round strainer, drain outlet size shall be as indicated on drawings.

C. (FD-2) Floor Drain - Garage equipment Floor Drain: Shallow Sump
   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.
      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 2350-MBG.

D. (FD-3) Emergency Floor Drain - Finished Mechanical Spaces.:
   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, 7" round nickel bronze strainer.
      a. Deep Seal P-trap
      b. Provide 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 2005-NB with 7" round strainer, drain outlet size shall be as indicated on drawings.

2.6 FRESH AIR INLET

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

B. (FAI) Fresh Air Inlet
   1. Round perforated pipe cover with Polished Nickel Bronze finish and vandal proof screws, pipe clamp with set screw
   2. Basis of Design:
      a. J.R. Smith: Model 9005.

2.7 HOSE BIBBS

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

B. (HB-1) Interior Hose Bibbs:
   1. Chrome Plated Bronze or brass with integral wall flange, replaceable hexagonal disc, hose thread spout, interchangeable handwheel and loose key operation, integral vacuum breaker in conformance with ASSE 1011.
   2. Basis of Design: Woodford Model 40HT

2.8 NON FREEZE WALL HYDRANT

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

B. (NFWH-1) Enclosed Non-Freeze Wall Hydrants:
   1. ASSE 1019-B, ASSE 1052, ASSE 1053; freeze resistant, box type, self-draining type with polished bronze wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker.
   2. Installation Height: Approx.. 24" above grade (totally within same color masonry) Coordinate exact locations and elevations with architect prior to rough-in.
      a. Basis of Design: Jay R. Smith Manufacturing Company; Model 5519-WC-CL-NB (verify wall thickness in field)

2.9 SHOCK ABSORBERS/WATER HAMMER ARRESTORS

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

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

2.10 THERMOSTATIC MIXING VALVES

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

B. Lavatory Mixing Valves:
1. Temperature and pressure regulating Under-the-Counter combination tempering valves for temperature control to ASSE 1070 down to 0.5gpm. Maximum temperature setting 110°F.
   a. Powers Series LFE480 must be rated for minimum flow of 0.5 gpm.
   b. Zurn; Aquaguard Model ZW3870XLT (single temp faucet), ZW3870XLT-4P (dual temp faucet)

C. (MMV) Master Mixing Valves for Larger Flow Capacities and Domestic Water Heaters:
1. Single Hi-Lo Temperature and pressure regulating combination tempering valves for temperature control to ASSE 1017, parafin actuator, dirt resistance seat design rotatable triple duty checkstops on inlets, rough bronze finish, w/combination temperature/pressure gauge on outlet.

D. (ETV-1) Emergency Eyewash / Drench Hose 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 or chrome finishes, temperature gauge on outlet.
      a. Powers HydroGuard Series Emergency Tempering Valve with Dual Internal Cold Water Bypass: Model ES-150-11 Series

E. (ETV-2) Emergency Shower / Eyewash Combination Unit 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 or chrome finishes, temperature gauge on outlet.
      a. Powers HydroGuard XP Series Emergency Tempering Valve with Cold Water Bypass: Model ES-P-ETV Series

2.11 TRENCH DRAINS

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

B. (TD-1) Garage Drain
   1. Channels: 6" wide x 1 meter long presloped Polypropylene channels w/interlocking channels, radiused bottom, integral rebar support, and ductile iron frame with concrete frame anchors and ductile iron grate - (continuous lengths exceeding 15 meters may use alternating sloped/non-sloping channels, total quantity of channels and channel models as required to achieve length indicated on Plumbing Floor Plans drawings and Plumbing Details drawings.)
      a. Basis of Design: J.R.Smith Model 9931 series Enviroflow Trench Drain System
   2. Grate: Slotted Ductile Iron, ADA compliant, quicklock securing device, with steel rails
      a. Basis of Design: JR Smith Fig No. 9870-478-MADA
   3. Catch Basin: Polypropylene molded catch basin with 4 inch and 6 inch preformed no hub outlet connection, ductile iron frame, galvanized concrete anchors, and secured grate, Plastic sediment bucket.
      a. Basis of Design: JR Smith Fig. No. 9936-BP
   4. Required Accessories:
      a. Closing end caps (as required per layout drawing)
      b. Adjustable trench installation supports. (quantity as required for recommended installation procedure - all thread rod with nuts and washers secured to integral rebar support)
      c. P-Trap and floor cleanout on outlet of catch basin
   5. Coordinated Drawing - Trench drain Manufacturer/Supplier shall provide dimensioned drawing of coordinated trench drain layout to be included in product submittal. Layout shall include coordinated outlet locations, channel layout construction, all required accessories including endcaps, etc., and installation guides.
   6. Installation: P.C. shall install trench drains in accordance with all manufacturer's recommendations. P.C. shall employ the services of the manufacturers representative to assist in installation as required and to make a minimum of one site visit to inspect installation prior to concrete pour.

2.12 WASHDOWN CONNECTION BOX

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

B. (WB-1) Toilet Room/Locker Room Washdown Connection Box - Dual Temperature
   1. 304SS box, removable door with keyed cylinder lock, lead free stainless steel valve body and stop. 3/4in. Hot and Cold supply connections, 3/4" NPSH hose thread outlet connection with integral vacuum breaker, removable loose key wheel handle cartridge operated stop valve w/screwdriver stops.
   2. Basis of Design: Acorn Engineering Model 8156-SSLF

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Cleanouts
   1. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
   2. Encase exterior cleanouts in concrete flush with grade.
   3. Install floor cleanouts and floor drains at elevation to accommodate finished floor with strainer or cover flush with finish floor.

C. Floor drains
   1. Install floor drains at elevation to accommodate finished floor with strainer or cover flush with finish floor unless specifically noted otherwise.
   2. Provide Mechanical trap seal protection similar to ProSet Trapguards at all floor drain locations. Where required by Authority Having Jurisdiction, provide trap primers, trap primer connection on drain, and all associated piping to connect trap primer to drain.

D. Floor Sinks
   1. Install floor sinks at elevation to accommodate finished floor with strainer or cover flush with finish floor unless specifically noted otherwise or where required to be raised above the finish floor level by the local Health Department or Authority Having Jurisdiction.

E. Backflow preventers
   1. Install approved potable water protection devices on plumbing lines as indicated on drawings and where contamination of domestic water may occur; including boiler makeup water lines, chemical mixers within janitor rooms, fire sprinkler systems, irrigation systems, flush valves, interior and exterior hose bibbs. Additional backflow prevention is not required when the connected equipment is provided with integral backflow prevention in accordance with the International Plumbing Code and the equipment is permanently/directly connected to the water supply.
   2. Install all backflow preventers in easily accessible location to permit annual testing and maintenance max. 48" above finish floor.
   3. Provide pressure gauges on inlet and outlet piping of all backflow preventers.
   4. Pipe relief from all RPZ backflow preventers air gap drain fittings to nearest floor drain or approved discharge location.

F. Install water hammer arrestors complete with accessible isolation valve on water supply piping serving all washing machine outlets, urinals and water closet flush valves.

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

H. Trench Drains
   1. Contractor shall install trench drains in accordance with all manufacturer's recommendations. Contractor shall employ the services of the manufacturers representative to assist in installation as required and to make a minimum of one site visit to inspect installation prior to concrete pour.
   2. Contractor shall provide all concrete encasement and expansion control as noted on plumbing details and manufacturers installation recommendations.

END OF SECTION 22 1006

SECTION 22 1500 - COMPRESSED AIR SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aftercooler.

B. Air Compressor

C. Refrigerated Air Dryer.

D. Hose Reels and Accessories

E. Pipe and Pipe Fittings.

F. Pressure Reducing Station

G. Filter/Regulators

H. Filter/Regulator/Lubricators

1.2 RELATED REQUIREMENTS

A. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.

B. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

C. Section 22 05 53 - Identification for Plumbing Piping and Equipment:

D. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

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

B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2010.

C. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2011.

D. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2008.

E. 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.

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

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, hoisting and setting requirements, starting procedures.

E. Project Record Documents: Record actual locations of equipment and components. Modify shop drawings to indicate final locations.

F. Maintenance Data: Submit for air compressor, air receiver and accessories, after cooler, refrigerated air dryer, and pressure reducing station.

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 DELIVERY, STORAGE, AND HANDLING

A. Accept air compressors and piping on site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

B. Protect piping and equipment from weather and construction traffic.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for reciprocating air compressors.

PART 2 PRODUCTS

2.1 AIR COMPRESSORS

A. Manufacturers:
   1. Ingersoll Rand Compressed Air Solutions: http://air.ingersollrand.com.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. I-R Model 2475N7.5-P or equal, two stage unit with the following features:
   1. Cast iron two stage pump with Air Cooled Aftercooler Unit
   2. 7.5hp, 200 volt, 3 phase motor with factory mounted starter.
   3. 24 cfm with a maximum of 175 psi.
   4. 80V, 80 gallon vertical tank mounting of compressor.
   5. Unloading pressure switch w/unloaded start.
   6. Splash lubrication system.
   7. Stainless steel valves
   8. ASME tank with electronic drain valve, discharge isolation valve, relief valve.
   9. Baked on powder gray coat enamel
   10. Provide unit with "all Season T30" lubricant.
   11. Dry Clean Air Treatment package including type G & H Filter.

C. Provide new air dryer and install on outlet side of new air compressor unit.

D. Provide Intelliflow Pneumatic Flow Controller/Pressure Regulator on main supply to building.

E. Contractor is to provide one I-R 32305898 start up kit and two 38485330 compressor maintenance kits.

2.2 AIR DRYER

A. Manufacturers:
   1. Ingersoll Rand Compressed Air Solutions: http://air.ingersollrand.com.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Type: Self contained mechanical refrigeration type complete with heat exchanger, refrigeration compressor, automatic controls, moisture removal trap, internal wiring and piping, and full R-134a refrigerant charge, NEM 12 IP/42 Protection.

C. Air Connections: Inlet and outlet connections at same level, factory insulated.

D. Heat Exchangers: Aluminum brazed plate. Provide heat exchangers with automatic control system to bypass refrigeration system on low or no load condition.

E. Moisture Separator: Centrifugal type located at discharge of heat exchanger.

F. Refrigeration Unit: Hermetically sealed type to operate continuously to maintain specified 21 degrees F dew point. House unit in steel cabinet provided with access door and panel for maintenance and inspection.

G. Accessories: Air inlet temperature gage, air inlet pressure gage, on/off switch, high temperature light, power on light, refrigerant gage, air outlet temperature gage, air outlet pressure gage, electric timer Darin valve.

H. Capacity:
1. Provide unit to meet the following criteria.
   a. Discharge Air: 38 to 50 degrees F atmospheric dew point.
   b. Rated Air Flow: 25 cfm.
   c. Inlet Air Pressure: 120 psi.

I. Electrical Characteristics:
1. 1/6 hp, 3.6 amps120 volts, single phase, 60 Hz.

J. Basis of Design: Ingersoll Rand; Model D42IN or approved equal.

2.3 PIPE AND PIPE FITTINGS

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints: Threaded or welded to ASME B31.1.

2.4 VALVES

A. Ball Valves:
1. MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

B. Swing Check Valves:
1. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends.

2.5 UNIONS AND COUPLINGS

A. Unions:
1. Ferrous Pipe: 150 psi malleable iron threaded unions.

B. Flexible Connector: Neoprene with brass threaded connectors.

2.6 PRESSURE REDUCING VALVE

A. Pressure Reducing Station: Consisting of automatic reducing valve and bypass, and low pressure side relief valve and gage. Provide oil separator where indicated.

B. Valve Capacity: Reduce pressure from 200 psi to 30 psi, adjustable upwards from reduced pressure.

2.7 FILTER/REGULATORS

A. Provide Filter/regulator on each compressed air outlet as noted on plans confirm locations with owner prior to installation: Wilkerson Model B28-06-FLG0, with the following features: Refer to plans/details for locations
   1. 5 micron filter element
   2. Metal bowl, polycarbonate body
   3. 235 cfm rating
   4. Manual drain
   5. Adjustable pressure range, 0-125 psi
   6. Pressure gauge
   7. Integral sight dome and adjustable knob

2.8 FILTER/REGULATOR/LUBRICATORS

A. Provide Filter/regulator/lubricator on each compressed air outlet as noted on plans confirm locations with owner prior to installation: Wilkerson Model C28-06-FLG0, with the following features: Refer to plans/details for locations
   1. 5 micron filter element
   2. Metal bowl, polycarbonate body
   3. 130 cfm rating
   4. Manual drain
   5. Adjustable pressure range, 0-125 psi
   6. Pressure gauge
   7. Integral sight dome and adjustable knob
   8. Metal bowl lubricator

2.9 HOSE REEL AND ACCESSORIES

A. Ceiling or wall mounted hose reel: consists of a spring driven hose reel with maximum 300 psi pressure, complete with 50 foot of 1/2" pressure hose and mounting bracket.
   1. Provide approved quick disconnect fitting on hose outlet (fittings to match Owner's standards).
   2. Provide all required support steel for mounting. Coordinate in field with building structural steel supplier.
   3. Hose reel shall be Reelcraft Model A5850 OLP or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Install compressor unit on vibration isolators. Level and bolt in place. Refer to Section 22 05 48.

C. Make air cock and drain connection on horizontal casing.

D. Install replaceable cartridge type filter silencer of adequate capacity for each compressor.

E. Connect condensate drains to nearest floor drain.

F. Install valved drip connections at low points of piping system.

3.2 INSTALLATION (CONTINUED)

A. Install takeoffs to outlets from top of main, with shut off valve after take off. Slope take off piping to outlets.

B. Install compressed air couplings, female quick connectors, and pressure gages where outlets are indicated.

C. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

D. Identify piping system and components. Refer to Section 22 05 53.

3.3 FIELD QUALITY CONTROL

A. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1.

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

C. Cap and seal ends of piping when not connected to mechanical equipment.

END OF SECTION 22 1500

SECTION 22 3000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Domestic Hot Water Circulators.

B. Oil Separators

C. Instantaneous Point-of-Use Water Heaters

1.2 SUBMITTALS

A. Product Data:
1. Indicate pump type, capacity, power requirements.
2. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
3. Provide electrical characteristics and connection requirements.

B. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.3 QUALITY ASSURANCE

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

B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 DELIVERY, STORAGE, AND HANDLING

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

1.5 EXTRA MATERIALS

A. See Div. 01 specifications, for additional provisions.

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

1.6 OWNER INSTRUCTION/DEMONSTRATION

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

PART 2 PRODUCTS

2.1 IN LINE CIRCULATOR PUMPS

A. Manufacturers:
   1. Armstrong
   2. Grundfos
   3. Thrush
   4. Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. Casing: Lead Free Bronze or Stainless Steel rated for 125 psig working pressure, with stainless steel rotor assembly.

C. Impeller: 30% glass-filled Noryl or Bronze.

D. Shaft: Stainless steel w/ permanently lubricated stainless steel bearings

E. Seal: Silicon-Carbide rotating against a stationary ceramic seat.

F. Gaskets: EPDM

G. Controls: Programmable timer and Aquastat(provide programmable timer only as required by local AHJ)

H. Performance:
   1. Refer to Plumbing Detail drawings for pump sizes and requirements

2.2 OIL INTERCEPTORS/SEPARATORS

A. Acceptable Manufacturers
   1. Striem (Polypropylene OS Series)

B. Oil Separator:
   1. Description: seamless, rotationally-molded Polyethylene with minimum 1” uniform wall thickness, lifetime guaranteed and made in USA, furnished for above or below grade installation, integral baffle, with field adjustable riser system, built-in flow control and vent connections. Cover shall provide water/gas-tight seal and have H20 rated minimum 16,000 lbs load capacity.
   2. Capacities and Characteristics:
      a. Unit Dimensions: 68 in. (dia.) x 132 in. L
      b. Max. Flow rate: 314 gpm
      c. Liquid Capacity: 1,500 gal.
      d. Oil Retention Capacity: 488 gal.
      e. Solids Retention Capacity: 413 gal.
      f. Inlet and Outlet Pipe Size: 6 in. (Optional 4", 6", 8" - Coordinate with size as indicated on plans)
      g. Vent Pipe Size: 3 in.(Optional 2", 3" or 4"- Coordinate with size as indicated on plans)
      h. Installation Position: Underground with accessway collar risers to grade.
      i. Options to be provided:
         1) SR/LR Teleglide Risers (Verify required length in field prior to order)
         2) C24-HP (2) - H20 Rated Pickable Cast Iron Covers
         3) CS3 - Clean Sweep Coalescing media
         4) HDK-1 - High Water Table Hold Down Kit
         5) Alarm for high oil accumulation. Includes alarm probe to be installed in top of tank accessway and alarm panel with buzzer and light for indoor wall mount.
         6) Oil level monitoring system oil sensorprobe and UL listed, lockable Nema 4X alarm panel with high oil level alarm light and buzzer, test button, power on light, dry contacts for BAS connection.
   3. Basis of Design: Striem Oil Reserve™ oil/sand separator with Slick Stick oil level monitoring system Model No. OS-1500-CS3
   4. Contractor shall provide concrete reinforced relieving slab over top of entire unit, refer to details and manufacturer's recommendations for specifics on slab construction.

2.3 INSTANTANEOUS POINT-OF-USE WATER HEATERS

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

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

C. Construction: Manufacturer's standard

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

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

F. Cover: UL rated 94 Vo.

G. Mounting: Bracket or device for wall mounting.

H. Temperature Control: Microprocessor controlled, Factory pre-set, temperature-control thermostat for adjustable, outlet-water temperature (110F maximum setting for Public Lavatories and Conforming to ASSE1070 TR).

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

J. Schedule
   1. IWH-1 (Lavatory)
      a. Basis of Design: Chronomite model: CM-20L/208 (208V/1ph, 4.16 kW), 57F rise@.5gpm
   2. IWH-2 (at EEW-2)
      a. Basis of Design: Chronomite model: ER-120L/208_3ph (208V/3ph, 24.96 kW), 38F rise@4.5gpm

PART 3 EXECUTION

3.1 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Coordinate with plumbing piping and related electrical work/fuel piping for each piece of equipment to achieve operating system

C. Provide Concrete housekeeping base of sufficient size for all floor mounted equipment. Concrete bases shall be dowelled into floor decking. Coordinate all work with G.C. in field.

D. Recirculation Pumps
   1. Refer to Plumbing details 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 aquastat controls with E.C. in field.

E. Pumps:
   1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
   2. Provide vibration isolation/flexible connectors on inlet and outlet piping

F. Oil Interceptors/Separators
   1. Install Oil Interceptor/Separator in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification.
   2. Install in accordance with all requirements of local AHJ.
   3. Exterior Installations:
      a. Verify inverts for all below grade/below slab Oil interceptors/separators prior to beginning any work.
      b. Provide H-20 rated concrete relieving pad and heavy duty rated access covers as noted on plumbing drawings, details, and specifications.
      c. Provide access covers extended to grade. Verify required height of access cover extensions in field prior to order of oil interceptor/separator 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 reccommended anti-flotation device
      e. Provide buried detectable green warning tape warning tape directly over piping and at outside edges of underground interceptors.

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

END OF SECTION 22 3000

SECTION 22 3300 - ELECTRIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes electric water heaters and accessories.

1.3 REFERENCE STANDARDS

A. ICC (IPC) - International Plumbing Code; 2015.

B. ASHRAE/IES ; 90.1b-2019 - ASHRAE Standard Energy Efficient Design of New Buildings Except Low-rise Residential Buildings

C. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.

D. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, finishes and coatings, required clearances, methods of assembly of components, and piping and wiring connections.

B. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between factory-installed and field-installed wiring.

C. Product certificates signed by manufacturers of water heaters certifying that their products comply with specified requirements.

D. Maintenance data for water heaters to include in operation and maintenance manuals. Include startup instructions.

1.5 QUALITY ASSURANCE

A. NFPA Standard: Comply with NFPA 70, "National Electrical Code," for electrical components.

B. Listing and Labeling: Provide electrically operated water heaters, controls, and components specified in this Section that are listed and labeled.

C. Product Options: Drawings indicate size, profiles, connections, dimensional requirements, and characteristics of water heaters and accessories and are based on specific types and models indicated. Other manufacturers' water heaters and accessories with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

1.6 WARRANTY

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

B. Warranty Period: 5 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATERS, GENERAL

A. Specified manufacturer's standard components and features are acceptable where specific product requirements are not indicated.

B. Temperature Control: Adjustable thermostat, except for units where other arrangement is indicated or temperature is regulated by flow-control fitting.

C. Safety Control: Automatic, high-temperature-limit cutoff device or system on commercial units and where indicated. Include automatic low-water cutoff device or system on commercial units where indicated.

D. Interior Finish: Materials that comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.

E. Tappings: Factory fabricated of materials compatible with tank. Include tappings for piping connections, relief valves, pressure gage, thermometer, blow down, and controls as required and others as indicated. Attach tappings to tank before testing and labeling. Include tappings and connections as follows:
   1. 2-Inch NPS (DN50) and Smaller: Threaded ends.
   2. 2-1/2-Inch NPS (DN65) and Larger: Flanged ends.

F. Insulation: Fiberglass, polyurethane foam, or manufacturer's standard that is suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls.

G. Jacket: Steel, with baked-on enamel finish, except where otherwise specified.

H. Anode Rods: Factory installed, magnesium.

I. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.

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

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bradford White Corp.
      b. Rheem Mfg. Co.
      c. State Industries

B. Description: UL 174, but listed by manufacturer for commercial applications, or UL 1453, light-commercial, storage, electric water heater; with capacity of no less than 50 gal. (151 L), but not more than 120 gal. (454 L), and input not more than 12 kW. ASHRAE 90.1b compliant

C. Storage Tank Construction: Heavy gauge steel automatically rolled formed and welded; NSF-61 Glass/enamel lined, ASME B1.20.1 pipe thread tappings, 150-psig working-pressure rating. ASME rated construction
   1. Thermally insulated with minimum 2 inches glass fiber, comply with ASHRAE/IESNA 90.1, encased in corrosion-resistant steel jacket with baked-on enamel finish.

D. Heating Elements: (3) screw-in, immersion type incoloy element(s) wired for simultaneous operation.

E. Controls: Adjustable fast acting immersion style thermostats, high temperature limit energy cutoff system

F. Corrosion protection: Factory installed Magnesium anode rod(s)

G. Factory Installed Appurtenances:
   1. 1-1/2 in. Dielectric water connections
   2. Drain Valve: Low restriction brass ball-type complying with ASSE 1005.
   3. Insulation: Comply with ASHRAE/IESNA 90.1[or ASHRAE 90.2].
   4. Jacket: Steel with painted finish.
   5. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting at 150 psig (1035 kPa). Select relief valve with sensing element that extends into storage tank.

H. Vacuum Relief Valve: Comply with ASME PTC 25.3. Furnish for installation in piping.

I. Special Requirements: NSF 5 construction with legs for off-floor installation.

J. Warranty: 5 year tank warranty/1 year component part warranty

K. Water Heater Schedule
   1. DWH-1
      a. Location: Water Heater Room
      b. Water Heater Capacity: 50 Gallon
      c. Heater KW: 18 kW (3 elements - 6kw ea. wired for Simultaneous operation)
      d. Recovery: 74 gph
      e. Heater Voltage/Phase: 208/3
      f. Expansion Tank: Amtrol ST-12C (ASME rated)
      g. Basis of Design:
         1) Bradford White Model: CEHD50A-18-5CF (208V/3ph)

PART 3 - EXECUTION

3.1 CONCRETE BASES

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

3.2 WATER HEATER INSTALLATION

A. General: Install water heaters as indicated on drawings. Set and connect units according to manufacturer's written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturer's recommended clearances. Install so controls and devices are accessible for service.

B. Provide drain pan of adequate size for water heater with outlet piped to floor drain.

C. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 221005 Plumbing Piping.

D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install water heater drain piping (where indicated on drawings and details) as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains.

F. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Division 22.0519 - Meters and Gages for Plumbing Piping.

G. Install pressure gages on water heater piping when and as indicated. Pressure gages are specified in Division 22.0519 - Meters and Gages for Plumbing Piping.

H. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Install piping adjacent to water heaters to allow service and maintenance. In parallel water heater installations, install water piping to allow removal of one unit with second unit in service.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
   1. Connect hot- and cold-water piping to units with shutoff valves and unions. Connect hot-water circulating piping to unit with shutoff valve, check valve, and union.
   2. Make connections with dielectric fittings where piping is made of dissimilar metals.

B. Electrical Connections: Power wiring and disconnect switches are specified in Division 26 Sections. Arrange wiring to allow unit servicing.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

A. Perform the following final checks before startup:
   1. Fill water heaters with water.
   2. Check that piping system tests are complete.
   3. Check for piping connection leaks.
   4. Check and install appropriate aerators/flow Restrictors on fixtures at point of use heater applications
   5. Test operation of safety controls, relief valves, and devices.

B. Perform the following startup procedures:
   1. Energize electric circuits.
   2. Adjust operating controls.
   3. Adjust hot-water-outlet temperature settings.
   4. Adjust thermostatic mixing valve and balance hot water return system

END OF SECTION 22 3300

SECTION 22 4000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. (EEW) Emergency Eye Wash

B. (ES) Emergency Station

C. (EWC) Electric Water Coolers

D. (LAV) Lavatories.

E. (MR) Mop Receptors

F. (SH) Showers.

G. (SINK) Sinks.

H. (UR) Urinals

I. (WC) Water closets.

1.2 RELATED REQUIREMENTS

A. Division 01 Specifications

B. Section 07 9005 - Joint Sealers: Seal fixtures to walls and floors.

C. Section 22 1005 - Plumbing Piping.

D. Section 22 1006 - Plumbing Piping Specialties.

E. Section 22 3000 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2004.

B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2006.

C. ARI 1010 - Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; Air-Conditioning and Refrigeration Institute; 2002.

D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).

E. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.

F. ASME A112.19.2 - Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals; The American Society of Mechanical Engineers; 2008.

G. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; The American Society of Mechanical Engineers; 2008.

H. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 2005.

I. IBC2015 - ICC - International Building Code; 2015

J. IPC2015 - ICC - International Plumbing Code; 2015

1.4 SUBMITTALS

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

B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Samples: Submit two lavatory supply fittings.

D. Manufacturer's Instructions: Indicate installation methods and procedures.

E. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners's name and registered with manufacturer.

G. Maintenance Materials: Furnish the following for Owners use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Supply two sets of faucet washers.

1.5 QUALITY ASSURANCE

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

1.6 REGULATORY REQUIREMENTS

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for electric water cooler.

C. EXTRA MATERIALS
1. See Section 01 6000 - Project Requirements, for additional provisions.
2. Supply two sets of faucet washers, flush valve service kits, lavatory supply fittings, and toilet seats.
3. Supply two

PART 2 PRODUCTS

2.1 (EEW-#) EMERGENCY EYEWASH

A. Manufacturers:
   1. Acorn Safety: www.acorneng.com
   2. Guardian Equipment: gesafety.com
   3. Haws Co.: www.hawsco.com
   4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 1 specifications for additional information.

B. (EEW-1) WALL MOUNTED EYEWASH/DRENCH HOSE - Janitor's Closet
   1. Unit shall meet the provisions of ANSI Z358.1-2014 as both an eyewash and a drench hose.
      a. Two spray heads mounted side-by-side w/ “flip top” dust covers, internal flow control and filter
      b. 1/2" IPS chrome plated brass stay-open ball valve w/flag handle.
      c. 12' retractable coiled PVC hose(Max working pressure 180 psi)
      d. Wall mounting bracket
      e. Inline backflow preventer
   2. Provide signage and test/inspection record tag in accordance with ANSI Z358.1.
   3. Water Supply:
      a. 1/2" Tempered supply from Tempering Valve (ETV-1)
   4. Basis of Design:
      a. Guardian Safety Model: G5014-BP

2.2 (ES-#) EMERGENCY STATION (COMBINATION SHOWERS/EYEWASH)

A. Manufacturers:
   1. Acorn Safety: www.acorneng.com
   2. Guardian Equipment: gesafety.com
   3. Haws Co.: www.hawsco.com
   4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 1 specifications for additional information.

B. (ES-1) EYEWASH w/DRENCH HOSE - Garage area
   1. ANSI Z358.1, Wall mounted, Eye/Facewash, SS bowl, two ABS spray heads w/ “flip top” dust covers, internal flow control and filter. annodized aluminum wall bracket
   2. Provide with wall mounted drench hose unit, stay open squeeze handle, 8' hose(Max working pressure 200 psi), mounting bracket, in-line backflow preventer, and installation kit to install in combination with eyewash unit
   3. Provide signage and test/inspection record tag in accordance with ANSI Z358.1.
   4. Water Supply:
      a. 1/2" Tempered supply from Tempering Valve (ETV-1). Refer to specification section 22 1006 Plumbing Piping Specialties" for additional information. Locate tempering valve visible and accessible location.
   5. Basis of Design: Guardian Safety Model: G1750-HS-BP

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

A. Electric Water Cooler Manufacturers:
   1. Elkay Manufacturing Company: www.elkay.com.
   2. Haws Corporation: www.hawsco.com.
   3. Oasis: oasiswatercoolers.com
   4. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

B. (EWC-1) SURFACE MOUNTED, BI-LEVEL - BARRIER FREE, FILTERED, ELECTRIC WATER COOLER w/BOTTLE FILLER (VANDAL RESISTANT) - Refer to Drawings for locations.
   1. Water Cooler: Electric, mechanically refrigerated. Bi-level surface mounted with; stainless steel top, stainless steel body panels with #4 finish, elevated anti-squirt Chrome vandal resistant bubbler with flexible stream guard, automatic stream regulator, vandal resistant front push button activation, integral air cooled chiller, water filter.
   2. Bottle Filler: touchless sensor activation, visual filter monitor, green ticker bottle counter
   3. Chiller Capacity: 8 gallons per minute of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
   4. Electrical: 115V, 60Hz, 260 watts, 3.8 FLA, manufacturer provided cord and plug electrical connection
   5. Compliance Standards:
      a. ADA/ANSI A117.1
      b. NSF/ANSI 61 & 372
      c. NSF 42 & 53 (Filter)
      d. GreenSpec Listed
   6. Accessories
      a. In wall carrier
      b. Cane apron
   7. Basis of Design:
      a. Elkay: LVRCGRNTL8WSK- LKAPREZL - MLP200

2.4 (LAV-#) LAVATORIES

A. Manufacturers:
   1. Basin: (Vitreous China)
      a. American Standard Inc: www.americanstandard.com.
      b. Kohler Company: www.kohler.com.
      c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
   2. Manual Faucets:
      a. Delta Faucet, Commercial Faucets; www.deltafaucet.com
      b. Chicago: www.chicagofaucets.com.
      c. Moen Commercial: www.moen.com.
      d. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. 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 prior to Bid. Refer to Division 01 specifications for additional information.

B. (LAV-1) LAVATORY, VITREOUS CHINA, WALL HUNG - 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 backsplash, 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. Color: White
      c. Basis of Design: Kohler; Kingston K-2005, 21-1/4" x 18-1/8", wall hung, drilled for concealed arm carrier system
      d. Basis of Design: American Standard: Lucerne 0355.012, 20-1/2" x 18-1/4", wall hung, drilled for concealed arm carrier system
   2. Manual Faucet(Single Lever Handle): Solid cast brass, chrome plated, deck mounted
      a. Mounting: 4"centers
      b. Spout Style: Standard.
      c. Valve: ceramic cartridge with rotation limit stop
      d. Handles: Single Lever handle with H&C color coded indicators
      e. Water Supply: 1/2 inch IPS connections.
      f. Aerator: Vandal resistant, 0.5 GPM
      g. Finish: Polished chrome.
      h. Basis of Design:
         1) Moen Commercial: Model 8413F05
         2) Chicago Faucet: Model 420-E2805ABCP
   3. Accessories:
      a. Mixing Valve: Below deck thermostatic tempering valve conforming to ASSE 1070 standard.
      b. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
      c. Chrome plated perforated grid strainer.
      d. Commercial Grade, Loose key/Screwdriver operated, 1/4 turn, chrome plated angle stops.
      e. Flexible chrome plated copper supplies.
      f. LavGuard Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84. Truebro LavGuard or equal.
   4. Carrier:
      a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

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

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

B. (MR-1) MOP RECEPTOR - NEO-CORNER, FLOOR MOUNTED, TERAZZO
   1. Basin:
      a. 36 x 36 inch x 12 inch high, terrazzo, floor mounted, neo corner style with drop front, 1 inch wide shoulders, stainless steel shoulder guard, and tiling flange.
      b. Acorn: Model TNC-36
   2. Faucet: Chrome plated cast Brass, integral vacuum breaker, pail hook, wall support
      a. Basis of design: Moen Commercial, Model 8124
      b. Basis of design: Chicago Faucets: 897CCP
      c. Install check valves on hot and cold water supplies to faucet.
   3. Accessories:
      a. KH36 hose and clamp hanger bracket, 3 feet of 5/8 inch diameter plain end reinforced rubber hose.
      b. KMH Mop hanger.
      c. KWG2-36 Stainless steel wall guards
      d. KF36 tiling flange
      e. KDG3 Drain Gasket
   4. Refer to Mop Receptor Detail for additional accessories and installation. Provide HB-1 hose bibb with 3/4"C connection and provide EEW-1 Eyewash/Drench hose assembly. Refer to section 22 1006 Plumbing Piping Specialties" for additional information.

2.6 (SH-#) SHOWERS

A. Manufacturers
1. Surround:
a. Comfort Designs: www.comfortdesignsbathware.com
b. Aquarius: Aquariusproducts.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. Controls/Valving
a. Chicago Faucet, Inc Commerical Faucets: chicagofaucets.com
b. Moen Commercial: www.moen.com
c. Powers Controls: www.powerscontrols.com
d. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

B. (SH-1A/SH-1) MODULAR PANEL SHOWER UNIT w/MANUAL TEMPERATURE CONTROL - ACCESSIBLE (Locker Showers)
1. Surround/Base: Solid Surface Shower Receptors
a. 60"x30" ICC-ANSI A117.1 compliant
b. Material: Solid Surface finish w/molded fiberglass construction
c. Color and Pattern: As selected by Architect from manufacturer's full line.
d. Drain Trim: Integral front trench drain and 3/4" threshold
e. Recessed in floor as required for installation in accordance with ANSI A117.1
f. Accessories: wood grain phenolic fold up seat, 36" horizontal stainless steel grab bar on rear wall, 28" horizontal and 24" vertical stainless steel grab bar on side wall opposite seat, stainless steel curtain rod with mounting hardware
g. Basis of Design: Comfort Designs SST 6238 TR.75 L-Bar-1 (Order left/Right hand orientation as shown on architectural drawings)
2. Control Valve and Accessories
a. Chrome Plated T&P mixing valve(ASSE 1016 Type T/P) with deluxe metal handle, hot and cold water supply
b. Chrome Plated Diverter valve for hand shower w/deluxe metal handle
c. Chrome Plated Deluxe hand shower with 59" hose and non-positive shutoff and inline vacuum breaker
d. Chrome plated swivel shower head with adjustable spray control
e. Basis of Design:
1) Chicago: SH-TP1-00-021 w/763-CP diverter valve and trim and 600-CP fixed shower head

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

A. CONTRACTOR SHALL COORDINATE SPECIFIED SINK TYPE, SIZE, AND DIMENSIONAL REQUIREMENTS **WITH CASEWORK SUPPLIER IN FIELD PRIORTO RELEASE OF ORDER**. Contractor is responsible for final verification of size and type.

B. Manufacturers:
   1. Sink:
      a. Elkay Corporation: www.elkayusa.com.
      b. Just Manufacturing Co.: www.just.com..
      c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
   2. Supply Faucet:
      a. American Standard Commercial Faucets: www.americanstandard-us.com
      b. Chicago Faucet, Inc Commerical Faucets:
      c. Delta Faucet, Commercial Faucets:www.deltafaucets.com
      d. Moen Commercial: www.moen.com
      e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

C. (SINK-1) - Single Compartment Bowl - ADA - Break room etc.
   1. Sink: ASME A112.19.3; 19 in.(front to back) by 22 in. (side to side) by 5.5 in. (ADA) nominal outside dimensions 18 gage thick, Type 304 stainless steel, Drop in and undercoated, with ledge back drilled for trim (3-hole punch).
      a. Drain: 3-1/2 inch all metal crumb cup with strainer and 17 ga. tailpiece.(ADA units shall be provided with drain outlet centered-rear in bowl.
      b. Basis of Design:
         1) Elkay; Model LRAD2219 (5.5" Deep, Center-Rear Drain)
   2. Faucet: ASME A112.18.1; chrome plated metal construction, high arc swivel spout with pulldown spray, lever style handle w/duralast cartridge, 1.5 gpm.
      a. Basis of Design:
         1) Chicago 434-ABCP
         2) Moen Commercial; Model Arbor 7594 (w/trim plate for 3 hole faucet punch)
   3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver/loose key chrome plated 1/4 turn angle stops, rigid chrome plated copper or flexible woven stainless steel supplies.
   4. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84

D. (SINK-2) - Free Standing, Single Compartment Bowl - Work room, Mechanics Bay, etc.
   1. Sink: ASME A112.19.3; 24 in.(front to back) by 27 in. (side to side) by 14 in. deep, nominal outside dimensions 14 gage thick, Type 304 stainless steel, tubular 16 ga. stainless steel legs w adjustable feet, with backsplash ledge drilled for trim (2-hole punch).
      a. Drain: 3-1/2 inch grid strainer, rotary lever drain outllet, and 1-1/2" 17 ga. tailpiece.
      b. Basis of Design:
         1) Elkay; Model SS8124 w LK24RT drain outlet
   2. Faucet: ASME A112.18.1; chrome plated solid brass supply with high rise 6" swivel gooseneck spout, 2.2 gpm flow, backsplash mounted, with foot controls
      a. Basis of Design:
         1) T&S Model B-0502-537K
   3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, Commercail grade loose key chrome plated 1/4 turn angle stops, rigid chrome plated copper or flexible woven stainless steel supplies.

2.8 (WC-#) WATER CLOSETS

A. Manufacturers(All Water Closets)
1. Bowl:
   a. American Standard Inc: www.americanstandard.com.
   b. Kohler Company: www.kohler.com.
   c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
2. Flush Valves:
   a. Sloan Valve Company: www.sloanvalve.com.
   b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
3. Seats:
   a. American Standard: www.americanstandard.us.com
   b. Kohler Company: www.kohler.com.
   c. Bemis Manufacturing Company: www.bemismfg.com.
   d. Olsonite: www.olsonite.com.
   e. Kohler Company: www.kohler.com.
   f. Zurn industries, Inc: www.zurn.com.
   g. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
4. Carriers:
   a. JOSAM Company: www.josam.com.
   b. J.R. Smith Company: www.jrsmith.com.
   c. Mifab Drainage Products
   d. Zurn Industries, Inc: www.zurn.com.
   e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

B. (WC-1) WATER CLOSET, WALL HUNG (Toilet Rooms) Refer to Drawings for locations.
   1. Bowl: Vitreous china w/stain resistant antimicrobial finish, White, ASME A112.19.2, ANSI A117.1/ADA compliant, elongated rim, wall hung, siphon jet flush action, china bolt caps. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
      a. Flush Volume: 1.1 - 1.6 gallon per flush
      b. Supply Connection: 1-1/2 inch Top Spud
      c. Outlet Size: 4 in.
      d. Basis of Design:
         1) American Standard Inc; Model Afwall Millenium FloWise 3351.101 (wall hung, elongated, top spud)
         2) Kohler; Model Kingston Ultra K-84325-0 (wall hung, elongated, top spud)
   2. Flush Valve (Manual): ASME A112.18.1, diaphragm type
      a. Exposed Type: Chrome plated brass construction, complete with vacuum breaker, angle stop w/vandal resistant cap, sweat and solder kit with supply cover and escutcheon, and accessories.
      b. Flush Control: Manual Type w/oscillating, non-hold open handle
      c. Flush Volume: 1.6gpf
      d. Basis of design:
         1) Sloan Valve Company; Royal Model 111-1.6
   3. Seats:
      a. Solid white plastic, elongated, open front, extended back, stainless steel self-sustaining hinge, stainless steel or brass bolts, without cover and anti-microbial finish.
   4. Water Closet Carriers:
      a. ASME A112.6.1M; adjustable compact cast iron frame, minimum 500 lbs static load rating, integral drain hub and vent, metal nipple assembly, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. Provide horizontal and vertical drain units as required by installation methods.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

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

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 9005, color to match fixture.

F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

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

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

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

3.5 ADJUSTING

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

3.6 CLEANING

A. Clean plumbing fixtures and equipment.

3.7 SCHEDULES

A. Fixture Heights: Install fixtures to heights above finished floor as scheduled below, where not indicated otherwise on Achitectural Interior Elevations and Drawings.
   1. Water Closet:
      a. Standard: 15 inches to top of bowl.
      b. Accessible: 18 inches (17 inches min. - 19 inches max.) to top of seat.
      c. Accessible (Childerens Use - age 12 and younger): 15 inches (11 inches - 17 inches)
   2. Water Closet Flush Valves:
      a. Standard: 11 inches min. above bowl rim. (coordinate installation at Accessible locations with manufacturers reccomendations.)
      b. Accessible: 11 inches min. above bowl rim. max 44 inches above floor (field coordinate installation at Accessible locations with manufacturers reccomendations and grab bar installation.)
   3. Urinal:
      a. Standard: 24 inches to top of bowl rim.
      b. Accessible: 16 inches (17 inches max.) to top of bowl rim.
   4. Lavatory:
      a. Standard: 31 inches - 34 inches to top of basin rim.
      b. Accessible: 34 inches(max.) to top of basin rim.
   5. Drinking Fountain:
      a. Standard Adult: 40 inches (38 inches - 43 inches) to spout.
      b. Accessible: wheelchair (lower bowl) - 36 inches max. to top of spout.
      c. Accessible: standing persons (upper bowl) - (38 inches min.- 43 inches max.) to spout
   6. Emergency Eye and Face Wash:
      a. Standard: 36 inches to receptor rim
      b. Accessible: 36 inches max. to spray heads
   7. Emergency Shower:
      a. Standard: 84 inches to bottom of head.
   8. Showers:
      a. Standard: Male - 78 inches to showerhead, Female - 78 inches to showerhead.
      b. Accessible: Locate all controls 38 inches minimum-48 inches max above floor (measured from floor to highest point of control)

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

END OF SECTION 22 4000

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SECTION 23 0501 – HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 CONTRACTOR:

A. The term Contractor as used in the Specifications shall be understood to mean the people or firm awarded the Contract for the respective phases of work - Heating, Ventilating and/or Air Conditioning.

1.3 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.

1.4 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. Where the word "provide" is used in connection with a system, equipment, or an item it shall be understood to mean the furnishing and installing of the system, equipment or item on this project.

B. Where the phrase "as directed" is used, it shall be understood to mean as directed or instructed by the Architect or his authorized representative.

C. Where the word "shall" appears in these Specifications, it shall be understood to mean that the labor, material or performance which it describes, or is associated, is mandatory.

D. Where the words "to be" appear in these Specifications, it shall be understood to have the same interpretation as if the word "shall be" were inserted in their place.

E. Where the word "comparable" appears in these Specifications, it shall be understood to mean that any item of equipment or material which is specified with an absolute minimum of differences.

1.6 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. VRF Systems
3. Diffusers, grilles, and registers
4. Exhaust fans and Ceiling Fans
5. Refrigerant, and condensate piping systems
6. Terminal heating equipment
7. Automatic temperature control system

1.7 PHASING:

A. All work shall be undertaken to accomplish the work in phases as indicated on the phasing drawings and descriptions.

B. All work required to accomplish the work in the phases shall be included.

1.8 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.

1.9 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, the Department of Environmental Protection, 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.

1.10 FOREMAN

A. Each contractor must provide a competent foreman, subject to approval of the Construction Manager and Architect. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours. If work is occurring in more than one shift, provide a foreman for each shift.

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

1.11 WORKMANSHIP

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

1.12 WORK RESPONSIBILITY:

A. All base flashing shall be provided by the General Contractor, with all counterflashing by this contractor.

B. All structural supports required for the installation of equipment and materials shall be furnished by this contractor unless specifically shown on the structural drawings.

C. All concrete work and pads for the installation of equipment and materials shall be furnished by this contractor unless specifically shown on the general construction drawings.

1.13 COORDINATION OF WORK

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

1.14 ALIGNMENT:

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

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

1.15 LOCATION OF EQUIPMENT

A. All locations of plumbing, HVAC and fire protection equipment and pipe connections there to shall be verified by the Engineer 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. Refer to Division 1 requirements for project coordination.

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

1.16 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 to 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.

1.17 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.

1.18 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT, AND MATERIALS

A. The Contractor shall submit, with a letter of transmittal to the Architect, 6 sets of 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 in 6 sets 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. Submit electric copies of all submittals to the Construction Manager.

E. No equipment or materials shall be installed until final approval has been given by the Architect.

F. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number and specification section number, as appropriate on shop drawings.

G. 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.

H. On shop drawings, provide space for Contractor and Architect/Engineer review stamps.

I. 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.

1.19 APPROVED 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 listed within the specifications as an approved substitution. 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. All equipment other than the basis of design shall be considered a substitution.

1.20 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.

1.21 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. The Contractor 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.

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

1.23 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.

1.24 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.

1.25 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 and framing as shown on details.

F. Firestopping for non-plastic piping, ductwork shall be 3M, Dow, Corning fire caulk/packing or accepted equivalent. Install steel angles around duct penetrations. Refer to Section 07 8400. All fire stopping furnished by all contractors on the project shall have the same manufacturer.

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.

1.26 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.

1.27 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

1.28 CUTTING AND PATCHING:

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

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

C. All cutting and patching of every nature required in connection with these Contracts shall be done by each Contractor with mechanics experience in their respective lines of work. All patching shall match adjacent finishes.

D. All cutting in the building shall be done with great care so as not to leave an unsightly surface which may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through the fault of the Contractor, he shall be required at his own expense, to engage the General Contractor to replace the damaged materials with new materials.

E. Cutting and patching of the existing building shall be done by this Contractor. All holes cut shall be in a manner approved by the Architect and all patching shall be done so as to match the existing construction and finish. The Contractor shall patch all openings left in present walls, floors and ceilings when ductwork, piping and other materials are removed.

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

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

H. 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.

I. Contractor shall seal all ductwork and piping penetrations through walls and floors even if not fire rated.

1.29 PAINTING:

A. Provide corrosion inhibiting prime coating on all ferrous materials. Comply with Division 9 of the specifications

B. 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.

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

D. All grilles, louvers, etc. unless otherwise indicated shall be either furnished in or painted in a color selected by the Architect. 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.

E. Note that all exposed ductwork and exposed piping systems shall be painted by the G.C. See Division 9 of the specifications for requirements. Ductwork or piping in rooms without continuous ceilings shall be considered exposed.

1.30 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 <u>are not to be utilized for temporary heat</u> 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.
5. All energy recovery wheels must be removed from the units utilized for temporary conditioning, sealed and stored by the Contractor. They shall be reinstalled by the Contractor at final acceptance.

1.31 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. Flush and treat all systems in each phase as required to meet phasing requirements. See Section 23 2500.

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. Refer to Section 23 3100.

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.

E. 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.

F. 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.

G. After all tests have been made and the system proven satisfactory to the Architect, the Contractor shall go over the entire project, clean all equipment and material installed by him, and leave in a clean and working condition.

1.32 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 installation and 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.

1.33 OPERATION AND MAINTENANCE INSTRUCTIONS:

A. Upon the completion of this project, the Contractor shall deliver to the Architect for approval, three copies of an operating and maintenance manual consisting of the items outlined hereinafter.

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

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

1. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.

D. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and troubleshooting techniques. Specifications for lubricants and other required fluids shall be included.

E. A listing of all items of mechanical and electrical equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.

1. Copies of all A.S.M.E. pressure vessel certifications, state approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.
2. All of the materials shall be indexed by specification section, arranged categorically and be bound in a rigid, plastic covered, three ring binder.

1.34 GUARANTEE:

A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year from date of final acceptance. The Contractor shall provide free service including parts replacement 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.

D. Refrigeration compressors and heat exchanger circuits shall have a five year guarantee.

E. All warranties shall include parts and labor. Durations of equipment warranties shall begin when the building has been accepted by the Owner.

PART 2 – PRODUCTS

PART 2 – PRODUCTS - 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 2" above the finished floor line, and the end shall be filed to a smooth round finish.

C. This Contractor shall supply all pipe sleeves 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 pipes and sleeves shall be caulked air tight with a non-combustible inorganic material.

3.4 UNIONS

A. Unions shall be provided at all connections to each piece of equipment and on both sides of all automatic valves, and devices which 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: 4” between for piping services and 6” between piping services and electrical conduits.

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/Construction/Owner.

3.9 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.

3.10 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 of said chases or openings. Show all information on the coordination drawings.

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.

3.11 EQUIPMENT BASES AND SUPPORTS:

A. Provide housekeeping pads of concrete, minimum 4” thick and extending 4” beyond supported equipment.

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members. Brace and fasten and flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed.

END OF SECTION 23 0501

SECTION 23 0513 - 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 REFERENCES

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2000).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.

C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.

D. ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.

1.3 SUBMITTALS

A. See Section 01 3000 - 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.

1.4 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.

1.5 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.

1.6 WARRANTY

A. See Section 01 7800 - 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. TEFC type except where specifically noted otherwise.
2. Design for continuous operation in 40 degrees C environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. All motors shall be high efficiency type.

B. Provide motors with phase loss protection.

C. Motors for use with VFD's shall be designed and approved by the manufacturer for use with VFD's.

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

E. Insulation shall be Class B. Motors shall be 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.

2.3 ELECTRICAL CONNECTIONS

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

2.4 MOTOR CONTROLLERS

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

B. Magnetic starters shall be provided with "On-Off-Auto" switches on the starter.

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

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

E. Unless otherwise noted elsewhere, all magnetic motor starters controlled with a remote pilot device shall contain a control circuit 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.

2.5 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 Mechanical Contractor.

B. All exhaust and supply fans on the roof shall be provided with disconnecting means at the motors as an integral part of the equipment.

2.6 ENCLOSURES:

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

2.7 MOTOR CONTROL WIRING:

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

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

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

END OF SECTION 23 0513

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SECTION 23 0549 - 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 unisolated mechanical equipment shall be adequately secured to the structure.

F. Unless the equipment incorporates unit construction using an integral unit frame or is specified otherwise, each item of mechanical equipment, along with its drive unit, shall be mounted on a rigid steel or steel and concrete base. The equipment, including the base, shall be mounted on, or suspended from, vibration isolators to prevent the transmission of vibration and mechanically transmitted 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 inches shall be zinc plated, or coated with a polyester epoxy powder. Springs with a rated deflection capability greater than 2 inches may be painted. Zinc plating shall conform to ASTM B633, Class 2 SC2, minimum.

2.2 TYPE 1 MOUNTINGS - DOUBLE DEFLECTION NEOPRENE:

A. Double deflection neoprene mountings shall have a minimum rated static deflection of 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 0.75 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.

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 0.2 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.

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.

PART 3 - EXECUTION

3.1 PERFORMANCE OF VIBRATION ISOLATORS:

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

3.2 APPLICATIONS:

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

3.3 VIBRATION ISOLATOR/SEISMIC RESTRAINT SCHEDULE

A.

EQUIPMENT	TYPE	DEFLECTION
1. Suspended Air Handling Units	4	0.75”
2. In-Line Fans	4	0.75”
3. Condensing Units	1	0.40”

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

END OF SECTION 23 0549

SECTION 23 0554 - 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. In addition to this section, refer to drawings and/or other sections for complete extent of mechanical identification work required.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.4 SUBMITTALS:

A. Product Data: Submit product specifications and installation instructions for each identification material and device required.

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification materials or system.

PART 2 - PRODUCTS

2.1 MECHANICAL IDENTIFICATION MATERIALS:

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, 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 12" outside diameter of pipe or insulation: 24" long color field, 2-1/2" high letters.
   c. Ductwork: 2-1/2" high letters

D. 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.

3. Letter Size: 3"

E. 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.
8. For HVAC piping, use green background with white letters. Submit all designations prior to installation for approval and the following designations.

   a. Refrigerant Suction RS
   b. Refrigerant Liquid RL

C. 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. Exhaust Fans.
   c. VRF Indoor and Outdoor Units.
   d. Terminal heating units.

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.

END OF SECTION 23 0554

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SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Balancing work shall be included in the HVAC contract.

B. The Contractor shall cooperate with the balancing sub-contractor to properly adjust system components.

1.2 SECTION INCLUDES

A. Testing, adjustment, and balancing of hydronic systems.

B. Measurement of final operating condition of HVAC systems.

C. Sound measurement of equipment operating conditions.

D. Vibration measurement of equipment operating conditions.

1.3 REFERENCES

A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.

B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2008.

C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau; 2015, Seventh Edition.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

1.4 SUBMITTALS

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

B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

1. Submit to Architect.
2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
4. Include at least the following in the plan:

    a. Preface: An explanation of the intended use of the control system.
    b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
    c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
    d. Identification and types of measurement instruments to be used and their most recent calibration date.
    e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
    f. Final test report forms to be used.
    g. Detailed step-by-step procedures for TAB work for each system and issue, including:

        1) Terminal flow calibration (for each terminal type).
        2) Diffuser proportioning.
        3) Branch/submain proportioning.
        4) Total flow calculations.
        5) Rechecking.
        6) Diversity issues.

    h. Expected problems and solutions, etc.
    i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
    j. Details of how TOTAL flow will be determined; for example:

        1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
        2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.

    k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.

l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
n. Method of checking building static and exhaust fan and/or relief damper capacity.
o. Proposed selection points for sound measurements and sound measurement methods.
p. Methods for making coil or other system plant capacity measurements, if specified.
q. Time schedule for TAB work to be done in phases (by floor, etc.).
r. Description of TAB work for areas to be built out later, if any.
s. Time schedule for deferred or seasonal TAB work, if specified.
t. False loading of systems to complete TAB work, if specified.
u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
v. Interstitial cavity differential pressure measurements and calculations, if specified.
w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
x. Procedures for formal progress reports, including scope and frequency.
y. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

1. Revise TAB plan to reflect actual procedures and submit as part of final report.
2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
3. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
6. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE Std 111, or NEBB forms.
7. Include the following on the title page of each report:

a. Name of Testing, Adjusting, and Balancing Agency.
b. Address of Testing, Adjusting, and Balancing Agency.
c. Telephone number of Testing, Adjusting, and Balancing Agency.
d. Project name.
e. Project location.
f. Project Architect.
g. Project Engineer.
h. Project Contractor.
i. Report date.

1.5 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC MN-1, ASHRAE Std 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1. Maintain one copy of each document on site.

B. TAB Agency Qualifications: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience certified by AABC or NEBB.

C. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor experienced in performance of this Work and licensed at the Pennsylvania.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

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

1. AABC MN-1, AABC National Standards for Total System Balance.
2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
4. SMACNA HVAC Systems Testing, Adjusting, and Balancing.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of three years documented experience.
3. Certified by one of the following:

a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 TESTING, ADJUSTING, AND BALANCING AGENCIES

A. H.T. Lyons.

B. Optimum Performance Balancing.

C. Associated Air Balance Engineers.

D. Eastern Air Balancing

E. Mountain Air Balancing.

3.3 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Fans are rotating correctly.
6. Access doors are closed and duct end caps are in place.
7. Hydronic systems are flushed, filled, and vented.
8. Pumps are rotating correctly.
9. Proper strainer baskets are clean and in place.
10. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.4 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Affect 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.

3.7 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer
2. Model/Frame
3. HP/BHP
4. Phase, voltage, amperage; nameplate, actual, no load
5. RPM
6. Service factor
7. Starter size, rating, heater elements
8. Sheave Make/Size/Bore

B. 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

C. 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

D. 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

E. Air Moving Equipment:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and actual
7. Return air flow, specified and actual
8. Outside air flow, specified and actual
9. Total static pressure (total external), specified and actual
10. Inlet pressure
11. Discharge pressure
12. Sheave Make/Size/Bore
13. Number of Belts/Make/Size
14. Fan RPM

F. Return Air/Outside Air:

1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature
9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature
12. Design outside/return air ratio
13. Actual outside/return air ratio

G. Exhaust Fans:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Air flow, specified and actual
6. Total static pressure (total external), specified and actual
7. Inlet pressure
8. Discharge pressure
9. Sheave Make/Size/Bore
10. Number of Belts/Make/Size
11. Fan RPM

G. Duct Traverses:

1. System zone/branch
2. Duct size
3. Area
4. Design velocity
5. Design air flow
6. Test velocity
7. Test air flow
8. Duct static pressure
9. Air temperature
10. Air correction factor

I. Terminal Unit Data:

1. Manufacturer
2. Type(constant, variable, fan powered, single, dual duct)
3. Identification/number
4. Location
5. Model number
6. Size
7. Minimum static pressure
8. Minimum design air flow
9. Maximum design air flow
10. Maximum actual air flow
11. Inlet static pressure

J. 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

END OF SECTION 23 0593

SECTION 23 0714 - HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Duct insulation.

1.2 RELATED SECTIONS

A. Section 23 0554 – Mechanical Identification.

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

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

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

D. Submit MSS information for all products.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than five 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.

C. Store indoors or in suitable storage facilities. Do not store outdoors.

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.

2. Insulation: ASTM C 553-92; formaldehyde-free, flexible glass fiber, noncombustible blanket.

a. 'K' ('Ksi') value: 0.29 at 75 degrees F (0.042 at 24 degrees C), when tested in accordance with ASTM C 518.

1) Maximum Service Temperature: 250 degrees F (232 degrees C).
2) Maximum Water Vapor Sorption: 5.0 percent by weight.

3. Vapor Barrier Jacket:

a. 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.
b. Kraft paper with glass fiber yarn and bonded to aluminized film.
c. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
d. Secure with pressure sensitive tape.

4. 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).
5. Vapor Barrier Jacket:

a. Kraft paper with glass fiber yarn and bonded to aluminized film.
b. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
c. Secure with pressure sensitive tape.

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 welded pin 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 externally insulated with 2” thick fiberglass.

B. All exhaust and relief air ducts from the backdraft device to the louver shall be externally insulated with 1.5" thick fiberglass.

C. All supply and return air ductwork of air conditioning systems shall be externally insulated unless noted to be internally lined (except where ductwork is installed exposed in a conditioned space). Exposed and partially exposed ductwork shall be lined unless noted otherwise.

D. Dual Temperature Ductwork:

1. Application Requirements: Where leaving air temperature is alternately above and below ambient temperature insulate and vapor seal ductwork, except where ductwork is indicated to be acoustically lined.
2. Externally Insulated Ductwork: Provide with one of the following types and thicknesses of insulation, except as otherwise indicated:

a. Insulation: Rigid mineral fiber, 6 PCF in exposed areas, 1.5” thick with a minimum installed “R” value of 6.0.
b. Insulation: Flexible mineral fiber, 2" thick, application limited to concealed locations. Density shall be 1.5 pounds/cubic foot with a minimum installed “R” value of 6.0.

END OF SECTION 23 0714

SECTION 23 0719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 RELATED SECTIONS

A. Section 07 8400 - Firestopping.

B. Section 23 2113 - Hydronic Piping: Placement of hangers and hanger inserts.

C. Section 23 2300 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCES

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2007.

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; 2004.

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; 2009.

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; 2007.

I. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2007.

J. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2009.

K. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 2009.

L. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2009.

M. ASTM C 610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation; 2009.

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; 2010.

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

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. See Section 01 3000 - 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 five 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 E 84, NFPA 255, or UL 723.

2.2 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Armacell International: www.armacell.com.

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.

2.3 JACKETS

A. 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.

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 over 140 degrees F, insulate flanges and unions at equipment.

E. Inserts and Shields:

1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel, minimum 18 gauge) 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.

F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.

G. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

H. 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.

I. Install insulation of pipe systems subsequent to testing and acceptance of tests.

J. 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.

K. 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.

L. 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.

M. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

N. 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.

O. Replace damaged insulation which cannot be repaired satisfactorily including units with vapor barrier damage and moisture saturated units.

P. Protection: Insulation Installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.3 SCHEDULE

A. HVAC Systems:

1. HVAC PIPING SYSTEM INSULATION:

a. Sub-Freezing Piping (0 to 39 Deg. F.) (-18 to 4 Deg. C.):

1) Application Requirements: Insulate the following sub-freezing HVAC piping systems:

   (a) Refrigerant suction and liquid lines between evaporators and condensing units.

2) Insulate each piping system specified above with one of the following types and thickness of insulation:

   (a) Insulation: Flexible unicellular 1.0” thick.
   (b) Outdoor Application: Cover with 22 gauge corrugated aluminum with all joints sealed watertight.

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.

2) Insulate each piping system specified above with one of the following types and thicknesses of insulation:

   (a) Insulation: Flexible Unicellular; 1.0" thick.

END OF SECTION 23 0719

SECTION 23 0993 - 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. All operation equipment, devices, wiring, and system components required for the automatic temperature control system to shall be provided by the Contractor.

1.2 SUBMITTALS:

A. General: Submittals on temperature control work are required for shop drawings, manufacturer's data, operating instructions, maintenance manuals, wiring diagrams and the system guarantee and product warranties.

1.3 RELATED SECTIONS:

A. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Section 01 1000 – Summary of the Project.

PART 2 – CONTROLS

2.1 VRF SYSTEM:

A. System shall consist of an outdoor heat pump and indoor fan coil units. All components shall be controlled by manufacturer provided controllers and sensors with built-in sequences of operations.

B. Contractor shall install and wire all controllers and sensors provided by the unit manufacturer. All schedules and setpoints shall be programmed into the manufacturer’s central control panel per direction of the Owner.

C. Fan coil units shall be capable of heating and cooling. Unit supply fans shall run continuously when space is occupied and with heating and cooling to maintain occupied space temperature setpoints. Units shall be allowed to cycle their fans during unoccupied mode to maintain setback temperatures.

D. Anytime the fan coil unit supply fan is on the associated outside air damper shall open to provide ventilation air.

2.2 EXHAUST FAN CONTROL:

A. Those exhaust fans noted “Temperature" on the schedule shall be controlled based upon a factory provided space temperature sensor. Upon a rise in space temperature, above the setpoint of 80°F (adj.), the exhaust fan shall energize and any associated intake or exhaust dampers shall open (where applicable). On a fall in space temperature, the reverse shall occur.

B. Those exhaust fans noted "Detection Panel” on the schedule shall be controlled by the detection ventilation control panel. Upon detection of carbon monoxide or nitrogen dioxide, above concentration setpoints, the control panel shall command the exhaust fan to energize and any associated intake or exhaust dampers shall open (where applicable). Fan shall de-energize upon normal gas concentration levels and any dampers shall close.

C. Those exhaust fans noted "Switch" on the Exhaust Fan schedule shall be controlled by a wall switch, installed by the contractor, to energize or de-energize the fan. When the fan is energized any associated intake or exhaust damper shall open (where applicable), when the fan is de-energized the reverse shall occur.

2.3 CEILING FAN:

A. Fans shall be controlled via manufacturer supplied wall mounted controller. Install and wire controller provide by the unit manufacturer.

2.4 ELECTRIC UNIT & WALL HEATER CONTROL:

A. Electric heaters are equipped with factory provided controls and an integral thermostat. Upon a drop in room temperature, below setpoint of 70°F (adj.), fan and electric resistance heating coil shall energize. Upon a rise in room temperature, above setpoint, fan and electric resistance heating coil shall de-energize.

2.5 ELECTRIC INFRARED HEATER CONTROL:

A. Heaters shall be controlled in groups of 3 to 4 as shown the drawings through a low voltage thermostat. Heaters shall stage on/off to maintain a space temperature of 65°F (adj.).

2.6 DETECTION VENTILATION CONTROL PANEL & SENSORS:

A. Control panel, in conjunction with gas detectors, shall provide automatic control to help maintain an acceptable environment in space. Panel shall have a minimum of 12 analog (4-24mA) input channels, three 10A SPDT fan/alarm relays and two 24 VDC drivers for horn/strobes. Panel shall have a coverage area of up to 500,000 square feet and have an external display to show system and sensor status. All gas detection sensors shall utilize 12-24 VAC or 12-32 VDC input power and be compatible with control panel. Sensors shall have 5 A SPDT fan relay, 0.5A alarm relay, digital display, internal buzzer and have a coverage area of up to 5,000 square feet.

2.7 THERMOSTAT GUARDS:

A. Provide stainless steel covers over temperature sensors and switches located in Mechanic's, Garage, and Storage Bays.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Refer to the drawings for thermostat and control damper locations.

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 23 0993

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SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic system requirements.

B. Equipment drains and overflows.

C. Pipe hangers and supports.

D. Unions, flanges, mechanical couplings, and dielectric connections.

1.2 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 08 3100 - Access Doors and Panels.

C. Section 09 9000 - Painting and Coating.

D. Section 23 0553 – Mechanical Identification.

E. Section 23 0719 - HVAC Piping Insulation.

1.3 REFERENCE STANDARDS

A. ASME B31.9 - Building Services Piping; 2011 (ANSI/ASME B31.9).

B. ASTM B32 - Standard Specification for Solder Metal; 2008.

C. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.

D. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005 (Reapproved 2011).

E. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2012.

F. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2012.

G. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2009.

H. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.

I. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2006.

J. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).

K. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).

L. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007.

M. 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 Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data:

1. Include data on pipe materials, pipe fittings, valves, and accessories.
2. Provide manufacturers catalogue information.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

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 6000 - Product Requirements, for additional provisions.

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. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Protect piping systems from entry of foreign materials by temporary plugs, completing sections of the work, and isolating parts of completed system. Temporarily cap or plug incomplete piping sections at the end of each day.

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. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise. Indicate all drawings and supports on the coordination drawings.

2.2 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, or ASTM D2241, SDR 21 or 26.

1. Fittings: ASTM D2466 or D2467, PVC.
2. Joints: Solvent welded in accordance with ASTM D2855.
3. Do not use PVC in air plenums.

2.3 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with Section 23 2117.

2.4 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.

C. 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, cast bronze with solder joint end, or grooved end connections to match connecting piping.
d. Suitable for the required operating pressures and temperatures.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Prepare piping connections to equipment using jointing system specified.

C. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

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. Refer to Section 23 0501 and details.

G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

H. Slope piping and arrange to drain at low points.

I. Pipe Hangers and Supports:

1. Refer to Section 23 2117.
2. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-89.
3. Support horizontal piping as scheduled.
4. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
5. Place hangers within 12 inches of each horizontal elbow.
6. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
7. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
8. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
9. Provide copper plated hangers and supports for copper piping.
10. Prime coat all steel hangers and supports. Refer to Section 09 9000.

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 0719.

K. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.

L. Use eccentric reducers to maintain top of pipe level.

M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

N. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 9000.

3.3 INSPECTION:

A. 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.

3.4 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.
4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Plastic Piping.

1. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
2. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
3. 1-1/4 inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
4. 1-1/2 inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
5. 2 inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.

END OF SECTION 232113

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Grinnell

B. Approved Equal.

2.2 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.

2.3 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.

2.4 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.

2.5 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.

2.6 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. High Density Insert Insulation Saddles: Provide products manufactured by Elcen Metal Products Company or Armacell International.

2.7 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 chilled water piping, install coated protective shields.
   3. Saddles: Where insulation without vapor barrier is indicated (hot water piping), install protection saddles.

3.5 HYDRONIC PIPING

A. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP 89.

B. Hangers for Pipe Sizes 1/2 to 1-1/2”. Malleable iron adjustable swivel, split ring.

C. Hangers for Cold Pipe Sizes 2” and Over: Carbon steel, adjustable, clevis.

D. Hangers for Hot Pipe Sizes 2 to 4”. Carbon steel, adjustable, clevis.

E. Hangers for Hot Pipe Sizes 6” and Over: Adjustable steel yoke, cast iron roll, double hanger.

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

G. Multiple or Trapeze Hangers for Hot Pipe Sizes 6” and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

H. Wall Support for Pipe Sizes to 3”. Cast iron hook.

I. Wall Support for Pipe Sizes 4” and Over: Welded steel bracket and wrought steel clamp.

J. Wall Support for Hot Pipe Sizes 6” and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

K. Vertical Support: Steel riser clamp.

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

M. Floor Support for Hot Pipe Sizes to 4”: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

N. Floor Support for Hot Pipe Sizes 6” and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

O. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

3.6 ADJUSTMENT OF HANGERS AND SUPPORTS:

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

END OF SECTION 232117

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SECTION 23 2300 - 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.

1.2 RELATED REQUIREMENTS

A. Section 23 0719 - HVAC Piping Insulation.

1.3 REFERENCE STANDARDS

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2013 (ANSI/ASHRAE Std 15).

B. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2013.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.

D. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2013.

E. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2011 (ANSI/ASME B31.9).

F. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2013.

G. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.

H. 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.

1.5 SUBMITTALS

A. See Section 01 3000 - 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.

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 and licensed in Pennsylvania.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum ten years of documented experience.

1.7 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

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.

2.2 REFRIGERANT

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

B. Refrigerant: R-410a as defined in ASHRAE Std 34.

2.3 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.4 FILTER-DRIERS

A. Performance:

1. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
2. 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. 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. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.5.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Provide copper plated hangers and supports for copper piping.

F. 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.

G. Flood piping system with nitrogen when brazing.

H. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

3.3 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.4 CLOSEOUT

A. Provide documentation of the refrigerant charge quantity and pressure for each system.

END OF SECTION 23 2300

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SECTION 23 3100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

B. Casing and plenums.

1.2 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 09 9000 - Painting and Coating: Weld priming, weather resistant, paint or coating.

C. Section 23 0714 – HVAC Duct Insulation: External insulation.

D. Section 23 3300 - Air Duct Accessories.

E. Section 23 3700 - Air Outlets and Inlets.

1.3 REFERENCE STANDARDS

A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2009.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2008.

C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications; 2012.

D. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2012.

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.

F. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

G. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.

I. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2012.

J. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.

K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.

L. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.

1.4 SUBMITTALS

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

B. Product Data: Provide data for duct materials.

C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

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. Construct ductwork to NFPA 90A standards.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

A. All Ducts: Galvanized steel, unless otherwise indicated. All accessories shall be of the same material as the ductwork specified herein.

B. Low Pressure Supply: 2 inch w.g. pressure class, galvanized steel.

C. Return and Relief: 2 inch w.g. pressure class, galvanized steel.

D. General Exhaust: 2 inch w.g. pressure class, galvanized steel.

E. Shower Room Exhaust: Aluminum up to the point where it connects to the Locker Room Exhaust System.

F. Outside Air Intake: 2 inch w.g. pressure class, galvanized steel.

J. Transfer Air and Sound Boots: 1 inch w.g. pressure class, galvanized steel.

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. 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. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.

D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. 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. Provide turning vanes of perforated metal with closed cell foam insulation when acoustical lining is indicated.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.

F. Seal all joints and fittings

2.4 MANUFACTURED DUCTWORK AND FITTINGS

A. 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

PART 3 EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.

B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

3.3 CLEANING

A. The HVAC system shall be cleaned using source removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select source removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification. Means, methods and materials shall be as described in the NADCA General Specifications for the Cleaning of Commercial HVAC Systems manual, and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

B. Exposed ductwork shall have its exterior cleaned (in accordance with the manufacturer's recommended methods) to the satisfaction of the Architect.

END OF SECTION 23 3100

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SECTION 23 3300 - 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 3100 - HVAC Ducts and Casings.

B. Section 23 3600 - 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; 2018.

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 Section 01 3000 - 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. Provide two of each size and type of fusible link.

PART 2 - PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS - AIRFOIL TYPE

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 worm drive mechanism with removable key operator.

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 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 - Metal and Flexible, 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.

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 165 degrees F.

H. All dampers shall be dynamic type.

2.6 FLEXIBLE DUCT CONNECTIONS

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

B. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.

   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 - Metal and Flexible, 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.
3. Where rod lengths exceed 30 inches provide regulator at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 3100 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide 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 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 23 3300

SECTION 233416 – HVAC FANS

PART 1- GENERAL

1.1 SECTION INCLUDES

A. Direct Drive Sidewall Mounted Propeller Fans.

B. Centrifugal Inline Fans.

C. Centrifugal Ceiling Exhaust and Cabinet Fans.

D. Ceiling Fans

1.2 RELATED SECTIONS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

B. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

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/licenses/search.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.; 2006.

F. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

H. UL 705 - Power Ventilators; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

B. Product Data: Provide 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.

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 fan (if applicable).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Greenheck.

B. Loren Cook Company.

C. PennBarry.

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. Enclosed Safety Switches: Conform to NEMA 250.

2.3 DIRECT DRIVE SIDEWALL MOUNTED PROPELLER FANS

A. General Description:

1. Fan arrangement shall be exhaust.
2. Sidewall mounted applications.
3. Performance capabilities up to 7,100 cubic feet per minute (cfm) and static pressure to 0.625 inches of water gauge.
4. Fans are available in eight sizes with nominal wheel diameters ranging from 8 inches through 24 inches (8 - 24 unit sizes).
5. Maximum continuous operating temperature 130 Fahrenheit (54.4 Celsius).
6. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Wheel:

1. Propeller shall be aluminum blade riveted to steel hub.
2. A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft.
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.
4. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

C. Motors:

1. Motor Enclosure: Open drip proof - opening in the frame body and or end brackets.
2. Motors are permanently lubricated, sleeve bearing type on sizes 8-12 and ball bearing type on sizes 14-24 to match with the fan load and furnished at the specific voltage and phase.
3. Accessible for maintenance.

D. Drive Frame:

1. Drive frame assemblies and fan panels shall be galvanized steel.
2. Drive frame shall have welded wire or formed channels and fan panels shall have prepunched mounting holes, formed flanges and a deep formed one piece inlet venturi.

E. Disconnect Switches:

1. NEMA rated: Nema1.
2. Positive electrical shut-off.
3. Wired from fan motor to junction box.

F. Options/Accessories:

1. Dampers:

   a. Type: Gravity.
   b. Prevents outside air from entering back into the building when fan is off.
   c. Balanced for minimal resistance to flow.
   d. Galvanized frames with prepunched mounting holes.

2. Wall Housing Mounting:

   a. Fan panel will be mounted vertically directing the air horizontally out of the building. Wall Housing will be mounted in a manner that will not have any housing protruding outside of the building. Motor and drives will be accessible from the interior of the building.
   b. Constructed of galvanized steel with heavy gauge mounting flanges and prepunched mounting holes.
   c. Housing shall include OSHA approved motor guard.
   d. Final product will be fully assembled including motor and drives.

2.4 CENTRIFUGAL INLINE FANS

A. General Description:

1. Base fan performance at standard conditions (density 0.075 Lb/ft3)
2. Fan operating temperature shall be a minimum of 130 Fahrenheit (54.4 Celsius)

3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

B. Wheel:

1. Non-overloading, backward inclined centrifugal wheel
2. Constructed of aluminum
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
5. Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone.

C. Motors:

1. Motor enclosures: Open type
2. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable.
3. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
4. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
5. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
6. Motor shall be a minimum of 85% efficient at all speeds.

D. Housing:

1. Constructed of heavy gauge galvanized steel
2. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.

E. Spring Loaded Aluminum Backdraft Damper:

1. Prevents air from entering back into the building when fan is off
2. Eliminates rattling or unwanted backdrafts

F. Accessories:

1. Provide unit mounted disconnect switch.

2.5 CENTRIFUGAL CEILING EXHAUST AND CABINET FANS

A. General Description:

1. Fan shall be for ceiling mounted applications

2. Fan maximum operating temperature shall be a minimum of 130 Fahrenheit (54.4 Celsius)
3. UL/cUL listed 507 - Electric Fans
4. 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 galvanized steel
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. Motor shall be mounted on vibration isolators and be accessible for maintenance
4. Thermal overload protection

D. Housing:

1. Constructed of heavy gauge galvanized steel
2. Interior shall be lined with 0.5 inches of acoustical insulation

E. Spring Loaded Aluminum Backdraft Damper:

1. Prevents air from entering back into the building when fan is off
2. Eliminates rattling or unwanted backdrafts

F. Grille:

1. Types: Aluminum

G. Accessories:

1. Provide unit mounted disconnect switch.

2.6 CEILING FANS

A. Manufacturer:

1. Big Ass Fans; es6.
2. Pre-approved equal.

B. Construction:

1. Airfoils: 6 blades, constructed from aircraft grade aluminum, and tilted blade profile for maximum coverage area.
2. Motor: High efficiency, brushless DC/EC motor.
3. Controls: Fixed wall mount remote.
4. Onboard Sensor: Motion sensor.
5. Mounting: Flat or sloped ceilings 9’-0” or taller.
6. Accessories: none.
7. Finish: White or Black as selected by Architect.

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

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SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

C. Roof hoods.

1.2 REFERENCES

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2007.

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.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Kreuger.

B. Price.

C. Titus.

D. Metalaire

2.2 RECTANGULAR CEILING DIFFUSERS

A. Description: A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. Steel or aluminum induction blades shall be welded to each wing of the inner core. The induction blades shall be oriented at 45° angles in opposite directions to ensure rapid mixing of primary and room air. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.

B. Frame: Surface mount type. In ACT, where outer dimensions are 18x18 or greater, lay-in type shall be used.

C. Color: As shown on drawings.

D. Damper: Optional damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the diffuser by removing the spring loaded inner core assembly.

2.3 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Description: Grilles shall have 3/4-inch blade spacing. The fixed deflection blades shall be available parallel to the long or short dimension of the grille. Construction shall be of extruded steel or aluminum with a 1¼-inch wide border on all sides. Minimum border thickness shall be 0.040-0.050 inch. Sizes 24 x 24 inches and smaller shall be constructed using a roll-formed frame. Corners shall be welded with full penetration resistance welds. Sizes larger than 24 x 24 inches shall be constructed by using heavy steel or aluminum extrusions and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be counter-sunk for a neat appearance. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed in place by crimping or welding. Blade deflection angle shall be available at 35°.

B. Frame: Surface mounted with countersunk screw mounting. In ACT, where nominal dimensions are 18x18 or greater, lay-in type shall be used.

C. Color: As shown on drawings.

D. Damper: Optional opposed blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the grille.

2.4 WALL SUPPLY REGISTERS/GRILLES

A. Type: Supply grilles shall be double deflection. The deflection blades shall be available parallel to the long dimension of the grille or register. Construction shall be of steel or aluminum with a 1¼-inch wide border on all sides. Sizes 24 x 24 inches and below shall have roll-formed borders with a minimum thickness of 0.032 inch. Larger sizes shall be constructed using continuous steel or aluminum extrusions with a nominal thickness of 0.040 through 0.050 inch and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be countersunk for a neat appearance. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be spaced on 3/4-inch centers. Blades shall have friction pivots on both sides to allow individual blade adjustment without loosening or rattling or be inserted through the frame and held tight with steel friction wire interlocked to the frame on both ends of each side. Plastic blade pivots are not acceptable.

B. Frame: Surface mounted with countersunk screw mounting.

C. Damper: Optional opposed blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the grille.

2.5 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 airtight 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 099000.

END OF SECTION 233700

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SECTION 233750 – WALL LOUVERS

PART 1 GENERAL

1.1 SUMMARY

A. This sections includes fixed, extruded-aluminum louvers.

B. Related Sections include the following:

1. Division 07 Section “Joint Sealants”: Sealants installed in perimeter joints between louver frames and adjoining construction.

1.2 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.3 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg. F., ambient; 180 deg. F., material surfaces.

B. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer’s sock units identical to those provided, except for length and width according to AMCA 500-L.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

C. Samples for Verification: For each type of metal finish required.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2, “Structural Welding Code—Aluminum”.

C. SMACNA Standard: Comply with recommendations in SMACNA’s “Architectural Sheet Metal Manual” for fabrication, construction details, and installation procedures.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurement on Shop Drawings. Coordinate the requirements of the recessed flange installation with G.C.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck; Model ESD-603.

2. Pottorf; Model EFD-637.
3. Ruskin Company; Model ELF6375DX.

2.2 MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat-head screws for exposed fasteners, unless otherwise indicated.

D. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads for imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

A. Assemble louvers in factory in minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide subsills made of same material as louvers.

F. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.4 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:

1. Louver Depth: 6 inches.
2. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.80 inch.

3. Louver Blades: 45 degree slope with center baffle, return bend, and continuous blade reinforcing.
4. Mullion Type: Concealed structural mullions.
5. Free Area: Not less than 8.0 sq.ft. for 48-inch-wide by 48-inch high louver.
6. Frame construction shall contain integral flanges, to be mounted within brick courses. Coordinate the requirements with the G.C. prior to ordering.

2.5 LOUVER SCREENS

A. General: Provide screen at interior face of each exterior louver.

1. Screening Type: Bird screening for louvers connected to ducts; insect screening for louvers not connected to ducts.

B. Secure screens to louver frames with stainless-steel machine screws, spaces a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type for Bird Screening: Non-rewireable frame with a driven spline or insert for securing screen mesh.
4. Type for Insect Screening: Rewirable frame with a driven spline or insert for securing screen mesh.

D. Louver Screening:

1. Bird Screening: Aluminum, ½-inch-square mesh, 0.063-inch wire.
2. Insect Screening: Stainless steel, 18-by-18 mesh, 0.009-inch wire.

2.6 BLANK-OFF PANELS

A. Insulated Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets.

1. Thickness: 2 inches unless otherwise indicated.

2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
3. Insulating Core: Unfaced mineral-fiber or foamed-plastic rigid insulation board.
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with 1/8-by-1-inch PVC compression gaskets.
6. Panel Finish: Same type of finish applied to louvers, but black color.
7. Attach blank-off panels of louver frames with clips or stainless-steel, sheet metal screws.

2.7 ALUMINUM FINISH

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designating finishes.

B. Finish louvers after assembly.

C. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

D. High-Performance Organic-Coating Finish: AA-C12C42R1 x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Fluoropolymer Two-Coat Coating system: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
2. Color: Custom color to match Architect's sample.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or led washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fittings joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes to no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section “Joint Sealants” for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed surfaces of louvers that are not protected by temporary covering, to remote fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surface and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 233750

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SECTION 238101 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electric Unit Heaters.

B. Electric Wall Heaters.

C. Electric Infrared Heaters.

1.2 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.

1.3 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

1.4 EXTRA MATERIALS

A. Provide two sets of filters for each piece of equipment requiring filters.

PART 2 - PRODUCTS

2.1 GENERAL

A. The contractor shall furnish and install all equipment with required mounting components and accessories to meet size, capacity and characteristics as required on the Equipment Schedule or on the plans. Units shall be installed in accordance with specifications and manufacturer recommendations.

2.2 ELECTRIC UNIT HEATERS

A. Manufacturers:
   1. Berko.

2. Qmark.
3. Markel.

B. General: Heaters shall be UL listed and meet the requirements of the National Electrical Code. Heaters shall be of the draw-through air flow design to eliminate the element hot spots and extend design life.

C. Cabinet: The cabinet shall be made of 18 gauge die formed furniture grade steel. Individual adjustable louvers with 30 degrees downward stops shall be furnished to provide desired control of discharge air. All metal surfaces of the enclosure shall be phosphate coated to resist corrosion and finished in a durable polyester powder coat finish.

D. Motor: Motors shall be totally enclosed, designed for continuous heavy-duty all-angle operation and equipped with built-in thermal overload protection, with stainless steel louvers. Fans shall be constructed of aluminum and directly connected to the fan motor.

E. Heating element: The heating element wire shall consist of 80/20 Nichrome wire encased in refractory material (MGO) and have copper clad steel sheath for strength and corrosion resistance, and aluminum fins for faster heater transfer. Automatic reset thermal overheat protection shall be of the linear capillary type wired for instantaneous de-energizing in case of the thermal overload. Heater bank to have protective air inlet louvers.

F. Accessories: Provide power disconnect switch rated for unit capacity and mounting brackets designed for either ceiling or wall swivel mounting

2.3 ELECTRIC WALL HEATERS

A. Manufacturers:
1. Berko.
2. Qmark.
3. Markel.

B. General: Heaters shall be UL listed and meet the requirements of the National Electrical Code. Heaters shall be made up of back box, heater assembly, and a front panel. Thermostat shall have enclosed contacts and be completely concealed behind the front cover. A manual reset thermal cutout shall be built into the system to shut off the heater in the event of overheating. A disconnect switch shall be mounted on the back box for positive disconnect of power supply.

C. Enclosure: Back box shall be constructed of 20 gauge galvanized steel and be designed for duty as a recessed or surface mounted application. Back box shall contain knock-outs through which power leads are brought. Front panel shall be of the bar grille type and be constructed of 16 gauge cold rolled steel, welded into a uniform grille to direct the warmed air toward the floor. Front panel color shall be selected by architect from manufacturer's standard color chart.

D. Fan and Motor: Fan shall be fire bladed aluminum. Fan motor shall be totally enclosed.

E. Heating element: The heating element shall be of the non-glowing design consisting of a special resistance wire enclosure in a steel sheath to which steel plate fins are copper brazed. It shall be warranted for 5 years.

2.3 INFRARED ELECTRIC HEATERS

A. Manufacturers:
   1. Detroit Radiant Products Co.

B. General: high wattage, commercial-grade electric heater with interchangeable elements and various chassis options. Heaters are equipped with a specially designed reflector for optimal radiant heat output.

C. Wattage Range: 750 to 11,400 Watts.

D. Mounting Options: 0 to 45 degree adjustable brackets.

E. Lamp Elements: Medium wave, high-output medium wave, clear short wave, or ruby short wave.

F. Housing: Black powder-coated aluminized steel or stainless steel for added durability and corrosion resistance.

G. Certifications & Approvals: UL listed for indoor & outdoor commercial, outdoor residential.

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. Recessed Units: Install where indicated. Coordinate to assure correct recess size for recessed units.

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.

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.

END OF SECTION 238101

SECTION 238129 - VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Variable refrigerant volume HVAC system includes:

1. Outdoor/condensing units.
2. Indoor/evaporator units.
3. Branch selector units.
4. Refrigerant piping.
5. Zoning kits
6. Control panels.
7. Control wiring.

1.2 RELATED REQUIREMENTS

A. Section 23 23 00 - Refrigerant Piping: Additional requirements for refrigerant piping system.

1.3 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008.

B. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Addenda.

C. ITS (DIR) - Directory of Listed Products; current edition.

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

E. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings indicated in Contract Documents:

1. Outdoor/Central Units:

   a. Refrigerant Type and Size of Charge.
   b. Cooling Capacity: Btu/h (W).
   c. Heating Capacity: Btu/h (W).
   d. Cooling Input Power: Btu/h (kW).
   e. Heating Input Power: Btu/h (kW).
   f. Operating Temperature Range, Cooling and Heating.
   g. Air Flow: Cubic feet per minute (Cubic meters per second).
   h. Fan Curves.
   i. External Static Pressure (ESP): Inches WG (Pa).
   j. Sound Pressure Level: dB(A).
   k. Electrical Data:

      1) Maximum Circuit Amps (MCA).
      2) Maximum Fuse Amps (MFA).
      3) Maximum Starting Current (MSC).
      4) Full Load Amps (FLA).
      5) Total Over Current Amps (TOCA).
      6) Fan Motor: HP (W).

   l. Weight and Dimensions.
   m. Maximum number of indoor units that can be served.
   n. Maximum refrigerant piping run from outdoor/condenser unit to indoor/evaporator unit.
   o. Maximum height difference between outdoor/condenser unit to indoor/evaporator unit, both above and below.
   p. Control Options.

2. Indoor/Evaporator Units:

   a. Cooling Capacity: Btu/h (W).
   b. Heating Capacity: Btu/h (W).
   c. Cooling Input Power: Btu/h (kW).
   d. Heating Input Power: Btu/h (kW).
   e. Air Flow: Cubic feet per minute (Cubic meters per second).
   f. Fan Curves.
   g. External Static Pressure (ESP): Inches WG (Pa).
   h. Sound Pressure level: dB(A).
   i. Electrical Data:

      1) Maximum Circuit Amps (MCA).
      2) Maximum Fuse Amps (MFA).
      3) Maximum Starting Current (MSC).
      4) Full Load Amps (FLA).

5) Total Over Current Amps (TOCA).
6) Fan Motor: HP (W).

j. Maximum Lift of Built-in Condensate Pump.
k. Weight and Dimensions.
l. Control Options.

3. Control Panels: Complete description of options, control points, zones/groups.

C. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:

1. Detailed piping diagrams, with branch balancing devices.
2. Condensate piping routing, size, and pump connections.
3. Detailed power wiring diagrams.
4. Detailed control wiring diagrams.
5. Locations of required access through fixed construction.
6. Drawings required by manufacturer.

D. Design Data:

1. Provide design calculations showing that system will achieve performance specified.
2. Provide design data required by ASHRAE Std 90.1.

E. Operating and Maintenance Data:

1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
3. Identification of replaceable parts and local source of supply.

F. Warranty: Executed warranty, made out in Owner's name.

G. Project Record Documents: Record the following:

1. As-installed routing of refrigerant piping and condensate piping.
2. Locations of access panels.
3. Locations of control panels.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.

B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.8 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Compressors: Provide manufacturer's warranty for six (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of Daikin AC (Americas), Inc. according to Daikin's terms and conditions. All warranty service work shall be preformed by a Daikin factory trained service professional.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: The system design indicated in Contract Documents is based on equipment and system designed by Daikin AC; www.daikinac.com/#sle.

B. Pre-approved equal.

2.2 HVAC SYSTEM DESIGN

A. System Operation: Heating and cooling.

1. Zoning: Provide capability for temperature control for each individual indoor/evaporator unit independently of all other units.
2. Zoning: Provide heating/cooling selection for each individual indoor/evaporator unit independently of all other units.
3. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.
4. Conditioned spaces are indicated on drawings.
5. Outdoor/Condenser unit locations are indicated on drawings.
6. Indoor/Evaporator unit locations are indicated on drawings.
7. Required equipment unit capacities are indicated on drawings.
8. Refrigerant piping sizes are not indicated on drawings.
9. Connect equipment to condensate piping provided by others; condensate piping is indicated on drawings.

B. Cooling Mode Interior Performance:

1. Daytime Setpoint: 68 degrees F (20 degrees C), plus or minus 2 degrees F (1 degrees C).
2. Setpoint Range: 57 degrees F (14 degrees C) to 77 degrees F (25 degrees C).
3. Night Setback: 78 degrees F (25 degrees C).
4. Interior Relative Humidity: 20 percent, maximum.

C. Heating Mode Interior Performance:

1. Daytime Setpoint: 68 degrees F (20 degrees C), plus or minus 2 degrees F (1 degrees C).
2. Setpoint Range: 59 degrees F (15 degrees C) to 80 degrees F (27 degrees C).
3. Night Setback: 60 degrees F (15 degrees C).
4. Interior Relative Humidity: 10 percent, minimum.

D. Operating Temperature Ranges:

1. Cooling Mode Operating Range: minus 4 degrees F (minus 20 degrees C) to 110 degrees F (43 degrees C) dry bulb.
2. Heating Mode Operating Range: 0 degrees F (minus 18 degrees C) to 77 degrees F (25 degrees C) dry bulb; minus 4 degrees F (minus 20 degrees C) to 60 degrees F (16 degrees C) wet bulb; without low ambient controls or auxiliary heat source.

E. Refrigerant Piping Lengths: Provide equipment capable of serving system with following piping lengths without any oil traps:

1. Minimum Piping Length from Outdoor/Central Unit(s) to Furthest Terminal Unit: 540 feet (165 m), actual; 620 feet (189 m), equivalent.
2. Total Combined Liquid Line Length: 3280 feet (1000 m), minimum.
3. Minimum Piping Length Between Indoor Units: 49 feet (15 mm).

F. Control Wiring Lengths:

1. Between Outdoor/Condenser Unit and Indoor/Evaporator Unit: 6,665 feet (2031 m), minimum.
2. Between Outdoor/Condenser Unit and Central Controller: 3,330 feet (1015 m), minimum.
3. Between Indoor/Evaporator Unit and Remote Controller: 1,665 feet (507 m).

G. Controls: Provide the following control interfaces:

1. For Each Indoor/Evaporator Unit: One wall-mounted wired "local" controller, with temperature sensor; locate where indicated.
2. One central remote control panel for entire system; locate where indicated.
3. One time clock control panel for entire system; locate where indicated.

H. Local Controllers: Wall-mounted, wired, containing temperature sensor.

2.3 EQUIPMENT

A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.

1. Refrigerant: R-410A.
2. Performance Certification: AHRI Certified; www.ahrinet.org.
3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL, listed in ITS (DIR), and bearing the certification label.
4. Provide outdoor/condensing units capable of serving indoor unit capacity up to 200 percent of the capacity of the outdoor/condensing unit.
5. Provide units capable of serving the zones indicated.
6. Thermal Performance: Provide heating and cooling capacity as indicated, based on the following nominal operating conditions:
7. Energy Efficiency: Report EER and COP based on tests conducted at “full load” in accordance with AHRI 210/240 or alternate test method approved by U.S. Department of Energy.

B. Electrical Characteristics:

1. Power - Indoor Units: 208 to 230 Volts, single phase, 60 Hz.
2. 208-230 Voltage Range: 187 to 253 volts.

C. System Controls:

1. Include self diagnostic, auto-check functions to detect malfunctions and display the type and location.

D. Wiring:

1. Control Wiring: 18 AWG, 2-conductor, non-shielded, non-polarized, stranded cable.
2. Control Wiring Configuration: Daisy chain.

2.4 OUTDOOR/CONDENSING UNITS

A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.

1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
2. Refrigerant: Factory charged.

3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted, due to potential reduction in space temperature.
6. Sound Pressure Level: As specified, measured at 3 feet (one meter) from front of unit; provide night setback sound control as a standard feature; three selectable sound level steps of 55 dB, 50 dB, and 45 dB, maximum.
7. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.
8. Provide refrigerant auto-charging feature and refrigerant charge check function.
9. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
10. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
11. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
12. Controls: Provide contacts for electrical demand shedding.
13. Product:

    a. Daikin REYQ Series ("heat recovery").

B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.

1. Designed to allow side-by-side installation with minimum spacing.

C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.

1. Provide minimum of 2 fans for each condensing unit.
2. External Static Pressure: Factory set at 0.12 in WG (30 Pa), minimum.
3. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG (80 Pa), minimum; provide for mounting of field-installed ducts.
4. Fan Airflow: As indicated for specific equipment.
5. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.

D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance.

E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.

1. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.
2. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
3. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.
4. Provide oil separators and intelligent oil management system.
5. Provide spring mounted vibration isolators.

2.5 INDOOR/EVAPORATOR UNITS

A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.
2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.
3. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.

   a. Provide thermistor on liquid and gas lines.

4. Fans: Direct-drive, with statically and dynamically balanced impellers; high and low speeds unless otherwise indicated; motor thermally protected.
5. Return Air Filter: Washable long-life net filter with mildew proof resin, unless otherwise indicated.
6. Condensate Drainage: Built-in condensate drain pan with PVC drain connection.
7. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.

B. Recessed Ceiling Units - 2 FT by 2 FT: Four-way airflow cassette with central return air grille, sized for installation in standard 24 by 24 inch (610 by 610 mm) lay-in ceiling grid.

1. Cabinet Height: Maximum of 12 inches (305 mm) above face of ceiling.
2. Exposed Housing: White, impact resistant, with washable decoration panel.

3. Maintenance Access: All electrical components accessible through decoration panel.
4. Supply Airflow Adjustment:

    a. Via motorized louvers which can be horizontally and vertically adjusted from 0 to 90 degrees.
    b. Field-modifiable to 3-way and 2-way airflow.
    c. Three auto-swing positions, including standard, draft prevention and ceiling stain prevention.

5. Sound Pressure: Measured at low speed at 5 feet (1.5 m) below unit.
6. Fan: Direct-drive turbo type.
7. Condensate Pump: Built-in, with lift of 21 inches (533 mm), minimum.
8. Provide side-mounted supply air branch duct connection.
9. Provide side-mounted fresh air intake duct connection.

C. Concealed-In-Ceiling Units: Ducted horizontal discharge and return; galvanized steel cabinet.

1. Return Air Filter: Manufacturer's standard.
2. Sound Pressure: Measured at low speed at 5 feet (1.5 m) below unit.
3. Provide external static pressure switch adjustable for high efficiency filter operation
4. Condensate Pump: Built-in, with lift of 9 inches (229 mm), minimum.
5. Switch box accessible from side or bottom.

D. Wall Mounted Units:

1. Unit Cabinet: The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
2. Condensate pump: Model DACA-CP-1

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.

B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.

C. Notify Architect if conditions for installation are unsatisfactory.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

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

C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).

D. Coordinate with installers of systems and equipment connecting to this system.

3.3 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform system startup.

B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.

C. Adjust equipment for proper operation within manufacturer's published tolerances.

END OF SECTION 23 8129

SECTION 26 0100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SCOPE OF PROJECT:

A. Provide a complete and operating electrical installation in accordance with these specifications and accompanying contract drawings. This includes all required labor, materials, apparatus and supervision.

B. Without limiting or restricting the volume of work and solely for the convenience of the Contractor, the work to be performed in general, comprises the following:

1. Provide new Secondary Electrical Service.
2. Provide complete new distribution system.
3. New Lighting and Lighting Controls.
4. New Fire Alarm and Detection system with new addressable, voice alarm system.
5. New structured cabling system with Cat 6A plenum-rated UTP wiring.
6. Data wiring for Owners new video Surveillance System.
7. Control wiring for Division 23 equipment where shown on Division 26 documents.

1.3 INTENT OF THIS SECTION:

A. This Section is intended as a supplement to each of the following Sections of Division 26, 27, 28 ELECTRICAL.

B. Consider each article of this Section as a part of each of the following Sections insofar as such requirements may be termed applicable.

1.4 TRUE INTENT:

A. The Drawings and Specifications are intended to provide a complete and perfectly operating system. Therefore, it is specifically agreed and understood by the Contractor that anything, be it labor, material or equipment, which is not described in the Specifications or specifically shown on the Drawings, but is necessary for the operation and completion of a perfectly operating system, according to the true intent of the Specifications and Drawings and as interpreted by the architect, shall be furnished by the Contractor as a part of his Contract, at no extra charge, as though it were specifically detailed and described.

1.5 DEFINITIONS:

A. General - Basic Contract definitions are included in the Conditions of the Contract.

B. Indicated - The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.

C. Directed - Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.

D. Approved - The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications and requests, is limited to the Architects duties and responsibilities as stated in the Conditions of the Contract.

E. Regulation - The term regulation includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation and similar operations.

G. Install - The tem install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. Provide - The term provide means to furnish and install, complete and ready for the intended use.

I. Contractor - The Contractor or Electrical Contractor - The term means the Contractor responsible for all work under this section.

J. Installer - An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term experienced, when used with the term installer, means having a minimum of five previous projects similar in size and scope to this project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.

2. Trades - Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
3. Assigning Specialists - Certain Section of the Specifications require that specific construction activities are performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
    a. This requirement is not to be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

K. Testing Agencies - A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere and to report on and, if required, to interpret results of those inspections or tests.

1.6 VISITS TO SITE:

A. Attention is directed to the necessity for all the Electrical Contractor to visit the site and examine all conditions affecting the proper execution of this Contract. Submission of proposals shall be considered evidence that Contractors have visited and examined the site.

B. Existing contours and topography as indicated, are believed to be reasonably correct, but are not guaranteed. Where conditions at project site do not agree exactly with conditions as indicated, Contractor shall assume all responsibility for said discrepancy.

C. No extra payment will be allowed the Electrical Contractor for extra work caused by failure to visit, examine and clarify.

1.7 GENERAL:

A. Throughout the Specifications, types of material are specified by manufacturer's name. Where more than one manufacturer is mentioned, catalog and specification data is given for a specific manufacturer. Equal material produced by other manufacturers listed is acceptable. Refer to SPECIAL REQUIREMENTS - Division 1 for substitution of materials.

1.8 RULES AND REGULATIONS

A. Perform in accordance with the rules and regulations of the National Electric Code (NEC), International Building Code (IBC) and other Codes and Standards cited in this specification and the requirements of the Utility Companies serving this project.

B. Certificates of Approval in triplicate, for rough and finished wiring from a Certified Inspection Service must be delivered to the Engineer before final payment can be authorized.

C. Perform all work in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration) and any other national, state, or local authority having jurisdiction.

D. Perform all Construction, design, fabrication, tests, rating, and installation in compliance with the regulations of all local, state or national agencies having jurisdiction over the project. Pay all costs involved in work necessary to comply with these regulations.

E. The Contractor assumes all responsibility and liability for any code violations, damage or injury which occurs as a result of deviation from or a change to the requirements of these plans and specifications which has not been approved in writing by the Engineer.

1.9 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW:

A. Submit Shop Drawings in accordance with SUBMITTALS Division 1 and as indicated in subsequent Sections of this Division. Assume responsibility for quantities and correct mounting details. In addition, submit other shop drawings as may be requested by the Architect.

1. Metal Clad Cable
2. Building Wire
3. Conduit
4. Fittings
5. Wireways
6. Outlet Boxes
7. Switches
8. Receptacles
9. Dry-type energy-efficient transformers
10. Electronic Circuit Monitors
11. Panelboards and Circuit Breakers
12. Safety Switches and Fuses
13. Fire Alarm & Detection System Equipment
14. Access Control System Equipment.
15. Structured Cabling system.
16. Automatic Transfer Switches (ATS's)
17. Interior Lighting
18. Lighting controls
19. Master clock System.

1.10 DRAWINGS:

A. The Electrical drawings are indicative of the general arrangements and approximate sizes and relative locations of principal materials to be provided. Drawings are diagrammatic and are a graphic representation of contract requirements to best available standards at the scale required. Provide certain items such as pull boxes, offsets to clear interferences, and supports which are not specifically shown but which are obviously needed to make the system complete and operable.

B. Verify all grades, elevations, dimensions and clearances at the site.

C. Electrical riser and schematic diagrams generally indicate wiring to be used in various systems. Provide all work shown on diagrams whether or not it is duplicated on the plans.

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

1.11 ENVIRONMENTAL CONDITIONS:

A. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions or temperature in area or moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.

1.12 PROTECTION:

A. Provide effective protection against damage for all materials and equipment during shipment, and storage at the Project site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.

B. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.

C. Protect all rough and finished floors and finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor coverings. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

1.13 PRODUCT:

A. Have materials delivered to site. Unload and store materials in allotted location, and protect from damage. Deliver materials to their point of installation.

B. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

1.14 COMPLIANCE WITH GENERAL STANDARDS AND REGULATIONS:

A. Provide equipment that is in conformity with these specifications and applicable requirements of the following:

1. AASHTO American Assoc. of State Highway and Transportation Officials
2. ACI American Concrete Institute
3. AISC American Institute of Steel Construction
4. AISI American Iron and Steel Institute
5. ANSI American National Standards Institute
6. ASTM American Society for Testing and Materials
7. AWS American Welding Society
8. CBM Certified Ballast Manufacturers Assoc.
9. CRSI Concrete Reinforcing Steel Institute
10. EIA Electronic Industries Assoc.
11. ETL ETL Testing Laboratories Inc.
12. FM Factory Mutual Research Assoc.
13. ICEA Insulated Cable Engineers Association, Inc.
14. IEC International Electrotechnical Commission
15. IEEE Institute of Electrical and Electronic Engineers
16. IESNA Illuminating Engineering Society of North America
17. IMSA International Municipal Signal Association
18. LPI Lighting Protection Institute
19. NEC National Electric Code
20. NECA National Electrical Contractors Association
21. NEMA National Electrical Manufacturers Association
22. NETA International Electrical Testing Association
23. NFPA National Fire Protection Association
24. UL Underwriters Laboratories, Inc

1.15 COMPLIANCE WITH FEDERAL GOVERNMENT AGENCIES

A. Names and titles of federal government standard - or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard - Specification-producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to the date of the Contract Documents.

1. ADA Americans with Disabilities Act

2. CFR Code of Federal Regulations
3. EPA Environmental Protection Agency
4. FAA Federal Aviation Administration (US Dept. of Transportation)
5. FCC Federal Communication Commission
6. FS Federal Specification (from GSA); Specifications Unit (WFISIS)
7. MIL Military Standardization Documents (US Department of Defense) Naval Publications and Forms Center
8. OSHA Occupational Safety and Health Administration (US Department of Labor)
9. REA Rural Electrification Administration (US Department of Agriculture)

1.16 GUARANTEE:

A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year from the date of substantial completion of the **final phase of the project**. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.

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

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

PART 2 - PRODUCTS

2.1 Refer to Division 26 - ELECTRICAL

PART 3 - EXECUTION

3.1 LOCATION OF MATERIAL:

A. Locate all lighting fixtures, power apparatus, conduit, outlets and other materials to result in proper operation of the building and to avoid conflicts with the work of other trades. Obtain required location information sufficiently in advance of installation time to allow uninterrupted progress of the work. Check layouts of equipment with shop drawings of all trades to determine roughing-in requirements. Do not scale drawings for exact locations. Exercise proper judgment to secure a neat arrangement of conduit, piping, ductwork and other material; and to overcome local interferences to best advantage of the Project.

B. Where physical interferences cannot be resolved readily, consult with the Construction Manager and Architect and prepare dated, dimensioned drawings correcting the interferences. Obtain written approval of the Construction Manager and Architect for such changes and distribute the drawings to all interested parties as directed by the Construction Manager and Architect.

C. In modular panel ceilings, locate lights, detectors and similar equipment as shown on reflected ceiling plan. Arrange ceiling outlets symmetrically. Verify locations of all floor outlets with Architect before roughing-in.

D. Locate switches and other manually operated devices in a location easily accessible and convenient to operating personnel. If any such devices are mounted in a location deemed inaccessible or impractical, relocate devices at no increase in contract costs.

3.2 EARTHWORK:

A. Provide all excavation, backfill, shoring and similar work as required for the installation of the Work of this Division. Refer to the requirements of Excavation, Grading and Site Work, Section 33, and Earthwork, Division 2.

B. Protect roots of live trees encountered in excavation.

C. Where excavations at footings, foundations, and other structures are deeper than the angle of repose deemed adequate by Architect, backfill such excavations solidly with 3000 pound concrete.

D. Remove and dispose of excess excavated materials as directed by the Construction Manager or Architect.

3.3 FLASHING AND COUNTERFLASHING:

A. Provide metal flashing and counterflashing under Division 26 in accordance with SHEET METAL, Division 7, for all conduits penetrating the roof. Form counterflashing into a rainhood attached to conduit and passed down over top of flashing. Attach counterflashing to conduit with clamp, and waterproof with sealing compound.

B. Base flashing will be worked into roofing.

3.4 CHASES AND OPENINGS:

A. Openings, recesses and chases will be provided in the building construction as described in SUPPLEMENTAL GENERAL CONDITIONS. Make detailed dimensioned drawings under Division 26 where required by Architect.

3.5 CUTTING AND PATCHING:

A. Perform all cutting of existing building construction under Division 26 as required for installation of electrical work.

B. Perform cutting carefully so as not to damage the structure or leave unsightly surfaces that cannot be covered with plates, escutcheons, or other normal concealing construction. Patch unsightly conditions resulting from cutting as directed by the Construction Manager or Architect. Engage competent mechanics for patching.

3.6 CONCRETE:

A. Provide all concrete required for the work of Division 26 - ELECTRICAL, unless otherwise noted. Provide 3000 pound concrete in accordance with the provisions of Division- CONCRETE.

B. Provide concrete housing cleaning pads for all freestanding electrical equipment inside and site light bases outside building, unless otherwise noted. Include all required anchor bolts, fish plates, sleeves, inserts, conduit and miscellaneous hardware and have them installed in their proper location in all concrete foundations.

3.7 MOTOR STARTERS

A. Furnish all manual motor starters, and mount where shown on drawings.

B. Mount manual motor starters for roof fans in an accessible location inside the building to avoid affecting thermal devices by atmospheric conditions.

C. In general, magnetic motor starters will be delivered to the site with the equipment they control.

1. Starters furnished under Division 21, 22, and 23 will be delivered to the Electrical Contractor for installation and wiring. The Electrical Contractor shall mount the starters where shown on the Drawings, and provide power wiring to the starter, as well as power wiring from the starter to the motor. Control wiring will be provided under the HVAC Contract.
2. Equipment furnished under other Divisions and under other contracts generally will not be combination type. Provide disconnects as required by the NEC within site of the controller and motor.
3. Check running current of each motor and verify correct size of overload elements, and fuses in combination starters. Notify Architect in writing of all overload elements and fuses incorrectly sized, so that corrective action can be initiated.
4. Prepare a typewritten list of all motors in the project, and submit to Architect for delivery to the Owner. Include the following information for each motor:
   a. Function and nomenclature, as identified by the marking actually used in the field.
   b. Physical location in the building.
   c. Rated horsepower, voltage and phase.

d. Rated full load current.
e. Proper size of thermal overload element.
f. Mount all motor starters, except those factory mounted on equipment.

3.8 COLOR CODING OF WIRING

A. Color code all wiring in accordance with the following table. In general, use factory colored insulation. Use colored vinyl tape for black insulation on cables No. 8 and larger. Apply pressure sensitive tape in half-lap serving for distance of 6" at cable terminations, in pull boxes, manholes, panels, and similar locations.

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

3.9 PHASING

A. Phase building load centers and panelboards "A", "B", "C" top to bottom and left to right. Identify the neutral, although it may be in different locations for different equipment.

B. Connect transformers in all systems so that:

1. "A" Phase is terminated at "H1" connection.
2. "B" Phase is terminated at "H2" connection.
3. "C" Phase is terminated at "H3" connection.
4. "X1" connection shall be the "A" Phase.
5. "X2" connection shall be the "B" Phase.
6. "X3" connection shall be the "C" Phase.

C. Ascertain from Power Company phase identifications at the point of connection and thereafter carry out and maintain this consistent system of color coding, phase identification and positioning.

D. Verify phase rotation after all terminations at equipment have been made, by producing a 1-2-3 rotation on a phase sequence meter when connected to "A", "B", and "C" phases. Make phase rotation compatible with existing distribution system.

3.10 GROUNDING RESISTANCE TEST:

A. Provide grounding system resistance test to verify resistance. Maximum resistance shall be 5 ohms.

B. Send final certified test reports and Certifications to Construction Manager for approval and transmittal to the Owner in accordance with SUBMITTALS, Division 1.

3.11 INSPECTION AND CERTIFICATION:

A. Obtain and deliver a final Certificate of Approval from the applicable NEC inspection authority having jurisdiction. Make delivery to Construction Manager for transmittal to the Owner upon completion of the work and before final payment in accordance with PROJECT CLOSE-OUT, Division 1. Pay all charges made by the inspection authority and include their cost in the bid.

3.12 INSTALLATION:

A. Install equipment in accordance with manufacturer's recommendations.

3.13 EQUIPMENT BY OWNER:

A. The Owner will furnish certain equipment, and deliver this equipment to the site as stated in EQUIPMENT FURNISHED BY OWNER, Division 11. Provide final electrical connections as required.

3.14 AS-BUILT DRAWINGS:

A. During construction, the Contractor shall maintain a record set of installation prints. He shall record on these prints, all deviations from the Contract Drawings in pipe sizing, location, and details. The record set of installation prints shall be updated at the end of each month and shall be delivered to the Construction Manager and the Architect.

B. At the completion of the work, the Contractor shall forward these prints to the Construction Manager and the Architect for incorporation into the final As-Built Drawings.

3.15 INSTRUCTION TO EMPLOYEES:

A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him. The instruction shall be video recorded and a copy of the recording turned over to the Owner for future reference.

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

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

D. Instructions described shall be given for the following systems:

1. Fire Alarm & Detection System.
2. Master Clock System
3. Card Access System.
4. Security Detection and Alarm System.
5. Lighting control systems.

END OF SECTION 26 0100

SECTION 26 0513 – MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 PROJECT INCLUDES

A. Medium voltage cable.

B. Cable terminations.

1.2 RELATED REQUIREMENTS

A. Section 337119 - Electrical Underground Ducts and Manholes: Cable racks in manholes.

B. Section 260553 - Identification for Electrical Systems.

1.3 REFERENCE STANDARDS

A. IEEE 48 - IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV; Institute of Electrical and Electronic Engineers; 1996 (R2009).

B. NEMA WC 70 - Non-Shielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009.

C. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

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

1.4 SUBMITTALS

A. See Section 013300 – Submittal Procedures, for submittal procedures.

B. Product Data: Provide for cable, terminations, and accessories.

C. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual sizes and locations of cables.

F. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

G. Maintenance Data: Include instructions for testing and cleaning cable and accessories.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles of Project.

D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

E. Cable must meet all PECO requirements for use as service entrance conductors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Southwire Company: www.southwire.com

B. Prysmian Corp.

C. The Okonite Company.

D. Substitutions: See Section 016000 - Product Requirements.

2.2 CABLE

A. Medium Voltage Cable (Distribution downstream of service entrance): UL1072, rubber insulated cable. 100% insulation Level, MV-105.

1. Voltage: 33kV grounded.
2. Conductor: 4/0, 19-Strand Copper, compact round.
3. Construction: TRXLP insulation, similar to Southwire “Power Glide” cable. The cable shall have an overall polyethylene jacket.
4. Provide #2 AWG copper ground wire.
5. Substitutions: See Section 016000 - Product Requirements.

B. Medium Voltage Cable (Incoming PECO service entrance): PECO Approved Cable.

1. Voltage: 33kV grounded.
2. Conductor: 4/0, 19-Strand Aluminum.
3. Construction: EPR insulation with stranded conductor and 32x#14 bare copper concentric neutral.
4. Provide #2 AWG copper ground wire with cable per PECO requirements.
5. Substitutions: See Section 016000 - Product Requirements.

2.3 ACCESSORIES

A. Modular Cable Terminations: IEEE 48, Class 1, molded-rubber cable termination in kit form with stress cone, ground clamp, non-tracking rubber skirts, load break connector, rubber cap, and aerial lug.

B. Tape Terminations: IEEE 48; Class 1, tape termination kit with semi- conductive tape, stress control tape, splicing tape, vinyl plastic tape, stress cone, mechanical ground straps, and cable preparation kit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conduit, duct, trench, or manholes are ready to receive cable.

B. Verify routing and termination locations of cable bank prior to rough-in.

C. Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

3.2 PREPARATION

A. Use swab to clean conduits before pulling cables.

3.3 INSTALLATION

A. Avoid abrasion and other damage to cables during installation.

B. Use suitable lubricants and pulling equipment.

C. Sustain cable pulling tensions and bending radii below recommended limits.

D. Ground cable shield at each termination and splice.

E. Install cables in manholes along wall providing longest route.

F. Arrange cable in manholes to avoid interference with duct entrances.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 014000.

B. Inspect exposed cable sections for physical damage.

C. Inspect cable for proper connections as indicated.

D. Inspect shield grounding, cable supports, and terminations for proper installation.

E. Inspect and test in accordance with NETA STD ATS, except Section 4.

F. Perform inspections and tests listed in NETA STD ATS, Section 7.3.3.

3.5 PROTECTION

A. Protect installed cables from entrance of moisture.

END OF SECTION 260100

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Single conductor building wire.

B. Metal-clad cable.

C. Wire and cable for 600 volts and less.

D. Wiring connectors.

E. Electrical tape.

F. Heat shrink tubing.

G. Wire pulling lubricant.

1.2 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

C. Section 283100 - Fire Detection and Alarm: Fire alarm system conductors and cables.

D. Section 312316 - Excavation.

E 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 not exposed and permitted by code.
   b. Limit length where required by code, including fixture whips, to 6 feet.

2. In addition to other applicable restrictions, may not be used:
   a. Where not approved for use by the authority having jurisdiction.
   b. Where exposed to view.
   c. Where exposed to damage.
   d. For damp, wet, or corrosive locations.
   e. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.

H. Concealed Dry Interior Locations: Use MC Cable or 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 MC Cable or 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 or aluminum, 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. Provide sufficient support from building structural steel. Provide Wire in conduit where sufficient support intervals cannot be provided or maintained.

E. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

H. Terminate cables using suitable fittings.

1. Metal-Clad Cable (Type MC):
   a. Use listed fittings.
   b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

I. Install conductors with a minimum of 12 inches of slack at each outlet.

J. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

K. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
   a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
   b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
   a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
   b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
3. Wet Locations: Use heat shrink tubing.

M. Insulate ends of spare conductors using vinyl insulating electrical tape.

N. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

P. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 014000.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Ground access wells.

G. Grounding and bonding components.

1.2 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 260536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 033000 - Cast-in-Place Concrete.

E. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.3 REFERENCE STANDARDS

A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; Institute of Electrical and Electronic Engineers; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.

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

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

F. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2014.

G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

1.6 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Shop Drawings:

1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field quality control test reports.

F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.

2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
   a. Provide continuous grounding electrode conductors without splice or joint.
   b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal Building or Structure Frame:
   a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
4. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
6. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
   c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

F. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:

1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

H. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:
   a. Transformers (except autotransformers such as buck-boost transformers).
   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
   c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral

(grounded) conductors and ground on load side of separately derived system disconnect.

7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

I. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   b. Metal gas piping.

J. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
   a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
   b. Raceway Size: 3/4 inch unless otherwise indicated or required.
   c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

K. Cable Tray Systems: Also comply with Section 260536.

L. Pole-Mounted Luminaires: Also comply with Section 265600.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:

1. Use insulated copper conductors unless otherwise indicated.
   a. Exceptions:
      1) Use bare copper conductors where installed underground in direct contact with earth.
      2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
   a. Burndy: www.burndy.com.
   b. Thomas & Betts Corporation: www.tnb.com.
   c. Panduit.
   d. Substitutions: See Section 016000 - Product Requirements.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

F. Ground Access Wells:

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

2.3 PRODUCTS

A. Rod Electrodes: Copper.

1. Diameter: 3/4 inch.
2. Length: 10 feet.

B. Foundation Electrodes: 3/0 AWG.

2.4 CONNECTORS AND ACCESSORIES

A. Mechanical Connectors: Bronze.

B. Exothermic Connections:

C. Wire: Stranded copper.

D. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements meet code requirements. Provide additional supplemental grounding as required to meet requirements within this specification and code requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

C. Section 260534 - Conduit: Additional support and attachment requirements for conduits.

D. Section 260537 - Boxes: Additional support and attachment requirements for boxes.

E. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

F. Section 265600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

G. Conduit and equipment supports.

H. Anchors and fasteners.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.

D. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

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

G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
   a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
   c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: Comply with Section 055000.

C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.
3. Manufacturers:
   a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
   b. Erico International Corporation: www.erico.com.
   c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   d. Thomas & Betts Corporation: www.tnb.com.
   e. Substitutions: See Section 016000 - Product Requirements.

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

1. Manufacturers:
   a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
   b. Erico International Corporation: www.erico.com.
   c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   d. Thomas & Betts Corporation: www.tnb.com.
   e. Substitutions: See Section 016000 - Product Requirements.

E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

1. Comply with MFMA-4.
2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
3. Channel Material:
   a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
6. Manufacturers:
   a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
   b. Thomas & Betts Corporation: www.tnb.com.
   c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
   d. Substitutions: See Section 016000 - Product Requirements.

F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

1. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2 inch diameter.
   b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
   c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
   d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
   e. Outlet Boxes: 1/4 inch diameter.
   f. Luminaires: 1/4 inch diameter.

G. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Plastic and lead anchors are not permitted.
9. Powder-actuated fasteners are not permitted.
10. Hammer-driven anchors and fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Comply with MFMA-4.
    b. Channel Material: Use galvanized steel.
    c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
    d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
12. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
13. Manufacturers - Mechanical Anchors:
    a. Hilti, Inc: www.us.hilti.com.
    b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com.
    c. Powers Fasteners, Inc: www.powers.com.
    d. Simpson Strong-Tie Company Inc: www.strongtie.com.
    e. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from any roof or floor deck. **Provide support from structural steel only**.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Conduit Support and Attachment: Also comply with Section 260534.

J. Box Support and Attachment: Also comply with Section 260537.

K. Interior Luminaire Support and Attachment: Also comply with Section 265100.

L. Exterior Luminaire Support and Attachment: Also comply with Section 265600.

M. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

N. Secure fasteners according to manufacturer's recommended torque settings.

O. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26.0529

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SECTION 26 0534 - CONDUIT

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Intermediate metal conduit (IMC).

D. Flexible metal conduit (FMC).

E. Liquidtight flexible metal conduit (LFMC).

F. Electrical metallic tubing (EMT).

G. Rigid polyvinyl chloride (PVC) conduit.

H. Liquidtight flexible nonmetallic conduit (LFNC).

I. Conduit fittings.

J. Accessories.

K. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 078400 - Firestopping.

C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.

D. Section 260526 - Grounding and Bonding for Electrical Systems.

1. Includes additional requirements for fittings for grounding and bonding.

E. Section 260529 - Hangers and Supports for Electrical Systems.

F. Section 260535 - Surface Raceways.

G. Section 260537 - Boxes.

H. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

I. Section 262100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

J. Section 262701 - Electrical Service Entrance: Additional requirements for electrical service conduits.

K. Section 271005 - Structured Cabling for Voice and Data - Outside Plant and Inside Plant: Additional requirements for communications systems conduits.

L. Section 312316 - Excavation.

M. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

N. Section 312323 - Fill: Bedding and backfilling.

O. Section 337119 - Electrical Underground Ducts and Manholes.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.

D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2013.

G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; National Electrical Contractors Association; 2004.

H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.

I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2013.

K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2015.

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

M. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

N. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

O. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

P. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

T. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

U. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.

4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Shop Drawings:

1. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use rigid schedule 40 PVC conduit.
2. Exterior, Direct-Buried: Use rigid schedule 80 PVC conduit.
3. Exterior, Embedded Within Concrete: Use rigid schedule 40 PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit prior to sweeping up.
5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.
2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges.

E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.

1. Locations subject to physical damage include, but are not limited to:
   a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
   b. Where exposed below 20 feet in warehouse areas.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

M. Corrosive Locations Above Ground: Use aluminum rigid metal conduit.

1. Corrosive locations include, but are not limited to:
   a. Cooling towers.

N. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit.

O. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

1. Maximum Length: 6 feet.

P. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
   a. Transformers.
   b. Motors.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.2 PRODUCTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Electrical Service Conduits: Also comply with Section 262100.

C. Communications Systems Conduits: Also comply with Section 271005.

D. Fittings for Grounding and Bonding: Also comply with Section 260526.

E. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.

G. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4 inch (21 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 1/2 inch (16 mm) trade size.
4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
5. Underground, Interior: 3/4 inch (21 mm) trade size.
6. Underground, Exterior: 1 inch (27 mm) trade size.

H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use aluminum.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 INTERMEDIATE METAL CONDUIT (IMC)

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

B. Fittings:

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

2.6 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, Inc; www.afcweb.com.

2. Electri-Flex Company; www.electriflex.com.
3. International Metal Hose; www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.7 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:

1. AFC Cable Systems, Inc; www.afcweb.com.
2. Electri-Flex Company; www.electriflex.com.
3. International Metal Hose; www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.8 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube & Conduit; www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Picoma; http://www.picoma.com.
4. Wheatland Tube Company; www.wheatland.com.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:

1. Manufacturers:
   a. Bridgeport Fittings Inc: www.bptfittings.com.
   b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use compression (gland) type.
   a. Do not use indenter type connectors and couplings.
   b. Do not use set-screw type connectors and couplings.
5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.9 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

1. Cantex Inc: www.cantexinc.com.
2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
3. JM Eagle: www.jmeagle.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.10 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com.
2. Electri-Flex Company: www.electriflex.com.
3. International Metal Hose: www.metalhose.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.11 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

G. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

H. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
   c. Within joists in areas with no ceiling.
5. Unless otherwise approved, do not route conduits exposed:
   a. Across floors.
   b. Across roofs.
   c. Across top of parapet walls.
   d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
14. Group parallel conduits in the same area together on a common rack.

I. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.
10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

J. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.

5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

K. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

L. Underground Installation:

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

M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 033000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

N. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

O. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

P. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

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

R. Identify conduits in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

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

3.5 PROTECTION

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

END OF SECTION 26 0534

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SECTION 26 0537 - BOXES

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Floor boxes.

D. Underground boxes/enclosures.

E. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 078400 - Firestopping.

C. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

D. Section 260526 - Grounding and Bonding for Electrical Systems.

E. Section 260529 - Hangers and Supports for Electrical Systems.

F. Section 260534 - Conduit:

1. Conduit bodies and other fittings.
2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

G. Section 260535 - Surface Raceways:

1. Accessory boxes designed specifically for surface raceway systems.
2. Lay-in wireways and wiring troughs with removable covers.

H. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

I. Section 262726 - Wiring Devices:

1. Wall plates.

2. Floor box service fittings.
3. Poke-through assemblies.
4. Access floor boxes.
5. Additional requirements for locating boxes for wiring devices.

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

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2013 (ANSI/NEMA OS 1).

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

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

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

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

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

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

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

L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, floor boxes, and underground handhole enclosures.

1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground handhole enclosures.

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

1. See Section 016000 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use suitable concrete type boxes where flush-mounted in concrete.
6. Use suitable masonry type boxes where flush-mounted in masonry walls.
7. Use raised covers suitable for the type of wall construction and device configuration where required.
8. Use shallow boxes where required by the type of wall construction.
9. Do not use "through-wall" boxes designed for access from both sides of wall.
10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.

12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
15. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
    b. Communications Systems Outlets: Comply with Section 271005.
16. Wall Plates: Comply with Section 262726.
17. Manufacturers:

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    a. Indoor Clean, Dry Locations: Type 1, painted steel.
    b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
    b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:

D. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 262726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation. Provide floor boxes to meet the requirements of the project conditions with the number and type of required outlets as indicated on the drawings.
2. Use cast iron floor boxes within slab on grade.
3. Use sheet-steel or cast iron floor boxes within slab above grade.
4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
5. Manufacturer: Same as manufacturer of floor box service fittings.

E. Underground Boxes/Enclosures:

1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: as required per NEC or Indicated on Drawings..
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Provide logo on cover to indicate type of service.
5. Applications:
   a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
   b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 15 load rating.
   c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
2. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
3. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
4. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
   a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
   b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
5. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260534.
6. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
   a. Concealed above accessible suspended ceilings.
   b. Within joists in areas with no ceiling.
   c. Electrical rooms.
   d. Mechanical equipment rooms.

I. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

N. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

O. Underground Boxes/Enclosures:

1. Install enclosure on gravel base, minimum 6 inches deep.
2. Flush-mount enclosures located in concrete or paved areas.
3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
4. Provide cast-in-place concrete collar constructed in accordance with Section 033000, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

P. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

R. Close unused box openings.

S. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

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

U. Identify boxes in accordance with Section 260553.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 0537

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SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

C. Section 271005 - Structured Cabling for Voice and Data - Outside Plant and Inside Plant: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

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

D. NFPA 70E - Standard for Electrical Safety in the Workplace; National Fire Protection Association; 2015.

E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Switchboards:
      1) Identify voltage, phase and amperes.
      2) Identify power source and circuit number. Include location when not within sight of equipment.
      3) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   b. Panelboards:
      1) Identify voltage phase and amperes.
      2) Identify power source and circuit number. Include location when not within sight of equipment.
      3) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
      4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
      5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   c. Transformers:
      1) Identify kVA rating.
      2) Identify voltage and phase for primary and secondary.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Identify load(s) served. Include location when not within sight of equipment.
   d. Enclosed switches, circuit breakers, and motor controllers:
      1) Identify voltage phase and amperes.
      2) Identify power source and circuit number. Include location when not within sight of equipment.
      3) Identify load(s) served. Include location when not within sight of equipment.
   e. Enclosed Contactors:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
      4) Identify load(s) and associated circuits controlled. Include location.
   f. Transfer Switches:
      1) Identify voltage phase and amperes.
      2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
      3) Identify load(s) served. Include location when not within sight of equipment.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.
   b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
   c. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.
3. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
4. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
5. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
   a. Minimum Size: 3.5 by 5 inches.
   b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
6. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
7. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
8. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
9. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

C. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Identification for Communications Conductors and Cables: Comply with Section 271005.

3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
   a. At each source and load connection.
   b. Within boxes when more than one circuit is present.
   c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
5. Use underground warning tape to identify direct buried cables and conduits.

D. Identification for Boxes:

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

E. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 271005.
2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
3. Use identification label to identify fire alarm system devices.
   a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
4. Use identification label to identify serving branch circuit for all receptacles.
   a. For receptacles in public areas, provide identification on inside surface of wallplate.
5. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

F. Identification for Luminaires:

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

2.2 PRODUCTS

A. Identification Nameplates:

1. Manufacturers:
   a. Brimar Industries, Inc: www.brimar.com.
   b. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com.
   c. Seton Identification Products; _____: www.seton.com.
   d. Substitutions: See Section 016000 - Product Requirements.

2. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:
   a. Brady Corporation; _____: www.bradyid.com.
   b. Brother International Corporation: www.brother-usa.com.
   c. Panduit Corp: www.panduit.com.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
   a. System designation where applicable:
      1) Fire Alarm System: Identify with text "FIRE ALARM".
   b. Equipment designation or other approved description.
   c. Other information as indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1 inch.
   b. Equipment Designation: 1/2 inch.
   c. Other Information: 1/4 inch.
   d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:
   a. Normal Power System: White text on black background.
   b. Emergency Power System: White text on red background.
   c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

H. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

I. Locations:

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

J. Letter Size:

1. Use 1/8 inch letters for identifying individual equipment and loads.
2. Use 1/4 inch letters for identifying grouped equipment and loads.

K. 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.

L. Wire Markers

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

M. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

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

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

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

1. Do not use handwritten text.

Q. Minimum Text Height: 1/8 inch.

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

2.3 VOLTAGE MARKERS

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

B. Minimum Size:

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

C. Legend:

1. Markers for Voltage Identification: Highest voltage present.

2.4 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Brady Corporation; www.bradyid.com.
2. Brimar Industries, Inc: www.brimar.com.

3. Seton Identification Products; www.seton.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:

1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.5 WARNING SIGNS AND LABELS

A. Manufacturers:

1. Brimar Industries, Inc: www.brimar.com.
2. Clarion Safety Systems, LLC; www.clarionsafety.com.
3. Seton Identification Products; www.seton.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:

1. Materials:
   a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
   b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Boxes: Outside face of cover.
8. Conductors and Cables: Legible from the point of access.
9. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

3.4 EXISTING CONDITIONS

A. The Contractor shall field verify and correctly label all existing loads remaining in panels and panel directories. Where existing loads are noted on the contract drawings and do not exist, the contractor shall properly label the panel directory as “spare”.

END OF SECTION 26 0553

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SECTION 26 0573 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock risk assessment.

1. Includes arc flash hazard warning labels and apply to equipment.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.2 RELATED REQUIREMENTS

A. Section 260553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

B. Section 262100 - Low-Voltage Electrical Service Entrance.

C. Section 262413 - Switchboards.

D. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

B. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).

D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

F. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations - Includes 1584, 1584A and 1584B; 2002 (Amended 2011).

G. NEMA MG 1 - Motors and Generators; 2017.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

I. NFPA 70 - National Electrical Code; 2017.

J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Existing Installations: Provide labor for investigation to obtain information and Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Submit study reports prior to or concurrent with product submittals.
2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

C. Scheduling:

1. Arrange access to existing facility for data collection with Owner.
2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.5 SUBMITTALS

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

B. Study preparer's qualifications.

C. Study reports, stamped or sealed and signed by study preparer.

D. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.

1. Include characteristic time-current trip curves for protective devices.
2. Include impedance data for busway.
3. Include impedance data for engine generators.
4. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
5. Identify modifications made in accordance with studies that:
   a. Can be made at no additional cost to Owner.
   b. As submitted will involve a change to the contract sum.

E. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

F. Field quality control reports.

G. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

H. Project Record Documents: Revise studies as required to reflect as-built conditions.

1. Include hard copies with operation and maintenance data submittals.
2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.6 POWER SYSTEM STUDIES

A. Scope of Studies:

1. Perform analysis of both new and existing portions of electrical distribution system.
2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
   a. Known Operating Modes:
      1) Utility as source.
      2) Generator as source.
      3) Maintenance settings.

B. General Study Requirements:

1. Comply with NFPA 70.
2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:

1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
   a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
      1) Obtain up-to-date information from Utility Company.
      2) Utility Company: As indicated on drawings.
   b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
   c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
   d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
   e. Protective Devices:
      1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
      2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
   f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
   g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
2. Existing Installations:
   a. Provide the services of field testing agency or equipment manufacturer's representative to perform field data collection.
   b. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.

D. Short-Circuit Study:

1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
   a. Maximum utility fault currents.
   b. Maximum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:

1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Risk Assessment:

1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
   a. To clarify IEEE 1584 statement that "equipment below 240 V need not be considered unless it involves at least one 125 kVA or larger low-impedance transformer in its immediate power supply" for purposes of studies, study preparer to include equipment rated less than 240 V fed by transformers less than 125 kVA in calculations.
   b. For single-phase systems, study preparer to perform calculations assuming three-phase system in accordance with IEEE 1584, yielding conservative results.
3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
   a. Maximum and minimum utility fault currents.
   b. Maximum and minimum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:

1. General Requirements:
   a. Identify date of study and study preparer.
   b. Identify study methodology and software product(s) used.
   c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
   d. Identify base used for per unit values.
   e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
   f. Include conclusions and recommendations.
2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:

1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
2) Fault point X/R ratio.
3) Associated equipment short circuit current ratings.
b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.

3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):
      1) Partial single-line diagram identifying the portion of the system illustrated.
      2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
      3) Conductors: Damage curves.
      4) Transformers: Inrush points and damage curves.
      5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
      6) Motors: Full load current, starting curves, and damage curves.
      7) Capacitors: Full load current and damage curves.
   c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
      1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
      2) Include ground fault pickup and delay.
      3) Include fuse ratings.
      4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
      d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

4. Arc Flash and Shock Risk Assessment:
   a. For each scenario, identify at each bus location:
      1) Calculated incident energy and associated working distance.
      2) Calculated arc flash boundary.
      3) Bolted fault current.
      4) Arcing fault current.
      5) Clearing time.
      6) Arc gap distance.
   b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
   c. Identify locations where the calculated maximum incident energy exceeds 40 calories per sq cm.
   d. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.

1.7 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in the preparation of studies of similar type and complexity using specified computer software.

1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.
2. Study preparer may be employed by field testing agency.

B. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience.

C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

1. Acceptable Software Products:
   a. EasyPower LLC: www.easypower.com.
   b. ETAP/Operation Technology, Inc: www.etap.com.

PART 2 PRODUCTS

2.1 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

1. Materials: Comply with Section 260553.
2. Minimum Size: 4 by 6 inches.
3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
   a. Include orange header that reads “WARNING” where calculated incident energy is less than 40 calories per square cm.
   b. Include red header that reads “DANGER” where calculated incident energy is 40 calories per square cm or greater.
   c. Include the text “Arc Flash and Shock Hazard; Appropriate PPE Required” or approved equivalent.
   d. Include the following information:
      1) Arc flash boundary.
      2) Available incident energy and corresponding working distance.
      3) Nominal system voltage.
      4) Limited approach boundary.
      5) Restricted approach boundary.
      6) Equipment identification.
      7) Date calculations were performed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install arc flash warning labels in accordance with Section 260553.

3.2 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Adjust equipment and protective devices for compliance with studies and recommended settings.

E. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.

F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

END OF SECTION 26 0573

SECTION 26 0914 - ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Instrument transformers.

B. Meters and meter switches and relays.

1.2 RELATED REQUIREMENTS

A. Section 262413 – Switchboards: Switchboard metering.

1.3 REFERENCE STANDARDS

A. ANSI C12.1 – American National Standard Code for Electricity Metering; 2001.

B. ANSI C39.1 – American National Standard Requirements for Electrical Analog Indicating Instruments; 1981 (R1992).

C. IEC 60051-1 Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories – Part 1: Definitions and General Requirements Common To All Parts; 1997.

D. IEC 60051-2 Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories – Part 2: Special Requirements for Ammeters and Voltmeters; 1984.

E. IEEE C12.1 – American National Standard Code for Electricity Metering; Institute of Electrical and Electronic Engineers; 1988.

F. IEEE C57.13 – IEEE Standard Requirements for Instrument Transformers; Institute of Electrical and Electronic Engineers; 2008.

G. NFPA 70 – National Electrical Code; national Fire Protection Association; 2008.

1.4 SUBMITTALS

A. See Section 01 3300 – Administrative Requirements, for submittal procedures.

B. Product Data: Provide electrical ratings, adjustment ranges, enclosure type, outline dimensions, mounting dimensions, and terminal connection information.

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, installation, and starting of product.

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 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 MANUFACTURERS

A. Manufacturers:

1. Match Switchgear/Switchboard provider.
2. Substitutions: See Section 01 6000 – Product Requirements.

2.2 METERING TRANSFORMERS

A. Manufacturers:

1. Match Switchgear/Switchboard provider.
   a. Substitutions: See Section 01 6000 – Product Requirements.

B. Current Transformers: IEEE C57.13;5 ampere secondary, wound type, with single secondary winding and secondary shoring device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

C. Potential Transformers: IEEE C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.3 METERING CAPABILITIES

A. Capable of remote access through webpage interface with password protection.

B. Revenue grade.

C. Provide real time metering of the following:

1. Voltage (Line-to-Line, and Line-to-Neutral)
2. Current (each phase, and three phase)
3. Power factor (harmonic and real with phase angles)
4. Capability of setting alarm parameters with date and time stamp data logging (first-in, first-out)
5. Datalogging and retention of peak demands with time stamp until user reset.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION 26 0914

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SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors.

B. Outdoor photo controls.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260537 - Boxes.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 260918 - Remote Control Switching Devices: Remotely controlled devices for lighting control, including networked lighting controls, programmable relay panels, and remote control switching relays.

E. Section 260919 - Enclosed Contactors: Lighting contactors.

F. Section 262726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, fan speed controllers, and wall plates.

G. Section 265100 - Interior Lighting.

I. Section 265600 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment - Nonlocking (Button) Type Photocontrols; 2004 (R2010).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

D. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.

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

F. UL 773 - Plug-in Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

G. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

H. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

I. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

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

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:

1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.

D. Field Quality Control Reports.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

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

1. See Section 016000 - Product Requirements, for additional provisions.

H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturers required service conditions during and after installation.

1.9 WARRANTY

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

B. Provide five year manufacturer warranty for all occupancy sensors.

PART 2 PRODUCTS

2.1 ALL LIGHTING CONTROL DEVICES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

C. Products for Switching of Electronic Fluorescent Ballasts and LED Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.2 OCCUPANCY SENSORS

A. Manufacturers:

1. Same as Lighting Control System Manufacturer. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval a minimum of 10 working days prior to the bid date and must be made available to all bidders.
2. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. All Occupancy Sensors:

1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
2. Sensor Technology:
   a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
   b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
   c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.

5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
7. Turn-Off Delay: Field adjustable, up to a maximum time delay setting of not less than 15 minutes and not more than 30 minutes.
8. Sensitivity: Field adjustable.
9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
10. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above the selected level.
11. Compatibility: Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
12. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on the drawings.
13. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

C. Wall Switch Occupancy Sensors:

1. All Wall Switch Occupancy Sensors:
   a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
   b. Unless otherwise indicated or required to control the load indicated on the drawings, provide line voltage units with self-contained relay.
   c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
   d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
   e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

2.3 OUTDOOR PHOTO CONTROLS

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com.
2. Paragon, a brand of Invensys Controls: www.invensyscontrols.com.
3. Tork, a division of NSI Industries LLC: www.tork.com.
4. Lutron Electronics
5. Substitutions: See Section 016000 - Product Requirements.
6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Stem-Mounted Outdoor Photo Controls:

1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
2. Housing: Weatherproof, impact resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Provide external sliding shield for field adjustment of light level activation.
5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
6. Voltage: As required to control the load indicated on the drawings.
7. Failure Mode: Fails to the on position.
8. Load Rating: As required to control the load indicated on the drawings.
9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

C. Locking Receptacle-Mounted Outdoor Photo Controls

1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.
2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.
8. Surge Protection: 160 joule metal oxide varistor.

D. Button Type Outdoor Photo Controls

1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.

3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of lighting control devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:

a. Wall Switch Occupancy Sensors: 48 inches above finished floor to the top of the box.

C. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.

G. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

H. Identify lighting control devices in accordance with Section 260553.

I. Occupancy Sensor Locations:

1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

J. Outdoor Photo Control Locations:

1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

L. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

M. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test outdoor photo controls to verify proper operation, including time delays where applicable.

E. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

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

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.

C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

D. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.

3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
4. Location: At project site.

END OF SECTION 26 0923

SECTION 262100 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical service requirements.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Materials and installation requirements for cast-in-place concrete equipment pads.

B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.

C. Section 260526 - Grounding and Bonding for Electrical Systems.

D. Section 260529 - Hangers and Supports for Electrical Systems.

E. Section 260534 - Conduit.

F. Section 260535 - Surface Raceways: Wireways.

G. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

H. Section 262300 - Low-Voltage Switchgear: Service entrance equipment.

1. Includes utility metering transformer compartment.
2. Includes non-utility electrical metering.

I. Section 262416 - Panelboards: Service entrance equipment.

J. Section 264300 - Surge Protective Devices: Service entrance surge protective devices.

K. Section 312316 - Excavation.

L. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

M. Section 312323 - Fill: Bedding and backfilling.

N. Section 337119 - Electrical Underground Ducts and Manholes.

1.3 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.4 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; Institute of Electrical and Electronic Engineers; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 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.

1.5 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.

B. Coordination:

1. Verify the following with Utility Company representative:
   a. Utility Company requirements, including division of responsibility.
   b. Exact location and details of utility point of connection.
   c. Utility easement requirements.
   d. Utility Company charges associated with providing service.
2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Owner.

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:

1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.6 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.
1. Obtain Utility company approval of shop drawings prior to submittal.

D. Drawings prepared by Utility Company.

E. Project Record Documents: Record actual locations of equipment and installed service routing.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. IEEE C2 (National Electrical Safety Code).
2. NFPA 70 (National Electrical Code).
3. The requirements of the Utility Company.
4. The requirements of the local authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Utility Company: PPL.

D. Division of Responsibility:

1. As follows:
   a. Utility Poles: Furnished and installed by Utility Company.
   b. Transformer furnished and installed by Utility Company. Transformer vault by Contractor. Vault shall comply with PPL requirements.
   c. Transformer Grounding Provisions: Provisions shall be by the Electrical Contractor. Ground grid by PPL. Refer and adhere to PPL Requirements.
   d. Primary: Underground Service from Utility Pole to Transformer. Coordinate with Utility to determine pole of service origin.
      1) Conduits: Furnished and installed by Contractor. Paths shall be coordinated with other utilities – existing and new.
      2) Conductors: Furnished and installed by Utility Company.
   e. Secondary Underground Service from Transformer to Switchboard
      1) Conduits: Furnished and installed by Contractor. Paths shall be coordinated with other utilities – existing and new.
      2) Conductors: Furnished and installed by Utility Company (Service Point at service entrance equipment).
2. Terminations at Service Point: Provided by Utility Company.
3. Metering Provisions:
   a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.
   b. Metering Transformer Cabinets: Furnished and installed by Contractor per Utility Company requirements.
   c. Metering Transformers: Furnished and installed by Utility Company.

d. Conduits Between Metering Transformers and Meters: Furnished and installed by Contractor per Utility Company requirements.
e. Wiring Between Metering Transformers and Meters: Furnished and installed by Utility Company.
f. Communications Conduits for Meters: Furnished and installed by Contractor per Utility Company requirements.

E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required trenching and backfilling in accordance with Section 312316 and Section 312323.

E. Provide required protective bollards in accordance with Utility Company requirements.

F. Provide required support and attachment components in accordance with Section 260529.

G. Provide grounding and bonding for service entrance equipment in accordance with Section 260526.

H. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 260553.

3.4 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION 26 2100

SECTION 26 2200 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General purpose transformers.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260534 - Conduit: Flexible conduit connections.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; current edition.

B. IEEE C57.94 - Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 1982 (R2006).

C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 2013.

D. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; National Electrical Contractors Association; 2009.

E. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; 2014.

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

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

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

I. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

J. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.5 SUBMITTALS

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

B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
   1. Vibration Isolators: Include attachment method and rated load and deflection.

C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Maintenance Data: Include recommended maintenance procedures and intervals.

H. Project Record Documents: Record actual locations of transformers.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

1.9 WARRANTY

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Schneider Electric; Square D Products: www.schneider-electric.us.

B. Eaton Corporation; www.eaton.com.

C. Siemens Industry, Inc; www.usa.siemens.com.

D. ABB.

E. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

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

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:

1. Altitude: Less than 3,300 feet.
2. Ambient Temperature:
   a. Greater than 10 kVA: Not exceeding 104 degrees F.
   b. Less than 10 kVA: Not exceeding 77 degrees F.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: 480 volts delta, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:

1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

E. Coil Conductors: Continuous copper windings with terminations brazed or welded.

F. Winding Taps:

1. Less than 3 kVA: None.
2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

H. Sound Levels: Standard sound levels complying with NEMA ST 20.

I. Mounting Provisions:

1. Less than 15 kVA: Suitable for wall mounting.
2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor clean, dry locations: Type 1.
   b. Outdoor locations: Type 3R.
2. Construction: Steel.
   a. Less than 15 kVA: Totally enclosed, non-ventilated.
   b. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

K. Accessories:

1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.4 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

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

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 260534, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

G. Mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.

H. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

I. Mount trapeze-mounted transformers as indicated.

J. Provide seismic restraints.

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

L. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

M. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.

N. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

O. Identify transformers in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.4 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2200

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SECTION 26 2413 - SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 264300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.

F. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

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

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

K. UL 891 - Switchboards; Current Edition, Including All Revisions.

L. UL 1053 - Ground-Fault Sensing and Relaying 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 required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Field Quality Control Test Reports.

E. 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.
3. Electronic Trip Circuit Breakers: Provide one portable test set.

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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Switchboards - Basis of Design: Schneider Electric (Square`D).

B. Switchboards - Other Acceptable Manufacturers:

1. ABB/GE; www.geindustrial.com/#sle.
2. Eaton Corporation; www.eaton.com/#sle.
3. Siemens Industry, Inc: www.usa.siemens.com/#sle.

C. Substitutions: See Section 016000 - Product Requirements.

D. Source Limitations: Furnish switchboards 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 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:

1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
   a. Altitude: Less than 6,600 feet.
   b. Ambient Temperature:
      1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:

F. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

G. Bussing: Sized in accordance with UL 891 temperature rise requirements.

1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Phase and Neutral Bus Material: Copper.
5. Ground Bus Material: Copper.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

1. Line Conductor Terminations:
   a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   b. Main and Neutral Lug Type: Mechanical.

2. Load Conductor Terminations:
   a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   b. Lug Type:
      1) Provide mechanical lugs unless otherwise indicated.

I. Enclosures:

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
   b. Outdoor Locations: Type 3R.
2. Finish: Manufacturer's standard unless otherwise indicated.
3. Outdoor Enclosures:
   a. Color: Manufacturer's standard.
   b. Access Doors: Lockable, with all locks keyed alike.

J. Future Provisions:

1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
3. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.

K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 264300, list switchboards as a complete assembly including surge protective device.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
   a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
   b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
   c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

M. Arc Flash Energy-Reducing Maintenance Switching: Provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

N. Owner Metering:

1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
2. See specification section 260914_ELECTRICAL POWER MONITORING for additional requirements.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:

1. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
   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.
2. Molded Case Circuit Breakers:
   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
      1) Provide electronic trip circuit breakers.
   b. Minimum Interrupting Capacity:

      65,000 rms symmetrical amperes at 480 VAC.
   c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
      1) Provide the following field-adjustable trip response settings:
         (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
         (b) Long time delay.
         (c) Short time pickup and delay.
         (d) Instantaneous pickup.
         (e) Ground fault pickup and delay where ground fault protection is indicated.

2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

d. Provide the following features and accessories where indicated or where required to complete installation:

1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

3. Insulated Case Circuit Breakers:

a. Description: Quick-make, quick-break, trip-free circuit breakers with two-step stored energy closing mechanism; standard 80 percent rated unless otherwise indicated; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

b. Operation:

1) Provide manually operated circuit breakers unless otherwise indicated.

2) Provide electrically operated circuit breakers where indicated.

c. Construction:

1) Provide fixed-mount circuit breakers unless otherwise indicated.

d. Minimum Interrupting Capacity:

1) 65,000 rms symmetrical amperes at 480 VAC.

e. Trip Units: Solid state, microprocessor-based, true rms sensing.

1) Provide the following field-adjustable trip response settings:

(a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

(b) Long time delay.

(c) Short time pickup and delay.

(d) Instantaneous pickup.

(e) Ground fault pickup and delay where ground fault protection is indicated.

2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

f. Provide the following features and accessories where indicated or where required to complete installation:

1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2.4 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:

1. Dielectric tests.
2. Mechanical operation tests.
3. Grounding of instrument transformer cases test.
4. Electrical operation and control wiring tests, including polarity and sequence tests.
5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

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 switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.

E. Provide required support and attachment in accordance with Section 260529.

F. Install switchboards plumb and level.

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

H. Install all field-installed devices, components, and accessories.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

K. Provide filler plates to cover unused spaces in switchboards.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

C. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

D. Inspect and test in accordance with NETA ATS, except Section 4.

E. Perform inspections and tests listed in NETA ATS, Section 7.1.

F. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 250amperes. Tests listed as optional are not required.

G. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

H. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

I. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

J. Test shunt trips to verify proper operation.

K. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.6 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 26 2413

SECTION 26 2416 - PANELBOARDS

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260529 - Hangers and Supports for Electrical Systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).

F. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.

H. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

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

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

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

L. UL 67 - Panelboards; Current Edition, Including All Revisions.

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

N. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

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

1. See Section 016000 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Schneider Electric; Square D Products: www.schneider-electric.us

B. Eaton Corporation; Cutler-Hammer Products:

C. Siemens

D. ABB

E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ALL PANELBOARDS

A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
2. Ambient Temperature:
   a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
3. Label equipment utilizing series ratings as required by NFPA 70.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 3R.
2. Boxes: Galvanized steel unless otherwise indicated.
   a. Provide wiring gutters sized to accommodate the conductors to be installed.
   b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
   c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

L. Load centers are not acceptable.

M. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

D. Circuit Breakers:

1. Provide bolt-on type secured with locking mechanical restraints.
2. Provide thermal magnetic circuit breakers for breakers 250Amp and smaller.
3. Provide electronic trip circuit breakers for breakers exceeding 250amps.

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:

1. Provide bolt-on type secured with locking mechanical restraints.
2. Provide thermal magnetic circuit breakers for breakers 250Amp and smaller.
3. Provide electronic trip circuit breakers for breakers exceeding 250amps.

D. 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. Electronic Trip Circuit Breakers: Furnish Solid State. Microprocessor-based, true RMS sensing trip Units with ling-time pick-up, long time delay, short time pick-up and delay, instantaneous pick-up, Ground-fault (where required by code or indicated on the drawings).
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
9. Do not use tandem circuit breakers.
10. Do not use handle ties in lieu of multi-pole circuit breakers.
11. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
12. 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.

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 26 2416

SECTION 26 2717 – EQUIPMENT WIRING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

A. Section 26 0534 - Conduit.

B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).

C. Section 26 0537 - Boxes.

D. Section 26 2818 - Enclosed Switches.

1.3 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).

B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).

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

1.4 SUBMITTALS

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

B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

1.5 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

1. Colors: Conform to NEMA WD 1.
2. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Wiring Devices: As specified in Section 26 2726.

C. Flexible Conduit: As specified in Section 26 0534.

D. Wire and Cable: As specified in Section 26 0519.

E. Boxes: As specified in Section 26 0537.

PART 3 EXECUTION

3.1 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 26 2717

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SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Line-voltage wall switches (See Lighting control device Specification for low-voltage lighting controls)

B. Receptacles.

C. Wall plates.

D. Floor box service fittings.

E. Poke-through assemblies.

1.2 RELATED REQUIREMENTS

A. Section 260537 - Boxes.

1.3 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).

E. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).

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

G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

K. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Lutron.

B. Hubbell.

C. Wattstopper.

D. Thomas & Betts.

E. Leviton.

2.2 APPLICATIONS

2.3 ALL WIRING DEVICES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

B. Finishes: Finishes and colors shall be selected by the Architect. Finishes and colors for devices installed at the same height shall match to the greatest extent possible.

2.4 WALL SWITCHES

A. Manufacturers: Shall match manufacturer of interior lighting controls

B. All Wall Switches: AC only, quiet operating, decora style switches (for HVAC control, use general-use snap switches) with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
2. Wall switches shall match the Lighting Control System as specified in Section 260924.

C. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with decora style switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.5 RECEPTACLES

A. Manufacturers:

B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.
3. Where connected to a Normal/Emergency circuit, provide red receptacles.

C. Convenience Receptacles: Provide tamper-resistant as required by code.

D. GFI Receptacles:

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

2.6 WALL PLATES

A. Manufacturers:

B. All Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard.
3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel. Provide oversize plates when installed in masonry walls. *Coordinate with Architect for the final decision on the finish and color of plates.*

D. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

E. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected.

2.7 FLOOR BOX SERVICE FITTINGS

A. Manufacturers: Legrand, Evolution Series.

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

2.8 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Legrand, Evolution Series.

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed. See description on drawings. Refer to description of devices on the drawings. Physical size shall be determined by both the devices and the cabling/conductors required. Architect shall select the finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

F. Verify that core drilled holes for poke-through assemblies are in proper locations.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of wiring devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:
2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

I. Provide GFI receptacles with integral GFI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

J. Install wiring devices plumb and level with mounting yoke held rigidly in place.

K. Install wall switches with OFF position down.

L. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

M. Do not share neutral conductor on branch circuits utilizing wall dimmers.

N. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

O. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

P. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

Q. Install poke-through closure plugs in all unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 014000.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Operate each wall switch with circuit energized and verify proper operation.

E. Verify that each receptacle device is energized.

F. Test each receptacle to verify operation and proper polarity.

G. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

H. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

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

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 2726

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SECTION 26 2813 – FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fuses.

1.2 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

B. Section 26 2818 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R2007).

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

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1.5 MAINTENANCE MATERIALS

A. See Section 01 6000 - Product Requirements, for additional provisions.

B. Furnish two fuse pullers.

C. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com.

B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.

C. Littelfuse, Inc: www.littelfuse.com.

D. Substitutions: See Section 01 6000 - Product Requirements.

2.2 FUSES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Main Service Switches Larger than 600 amperes: Class L (time delay), Low-peak.

H. Main Service Switches: Class RK1 (time delay), Low-peak.

I. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay), Low-peak.

J. Power Load Feeder Switches: Class RK1 (time delay), Low-peak.

K. Motor Load Feeder Switches: Class RK1 (time delay), Fusetron.

L. Lighting Load Feeder Switches Larger than 600 amperes: Class L time delay, Low-peak.

M. Lighting Load Feeder Switches: Class RK1 (time delay), Low-peak.

N. General Purpose Branch Circuits: Class RK1 (time delay), Low-peak.

O. Motor Branch Circuits: Class L time delay, Fusetron.

PART 3 EXECUTION

3.1 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 26 2813

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SECTION 26 2818 – ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed safety switches.

B. Fusible switches.

C. Nonfusible switches.

1.2 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 2813 - Fuses.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

C. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R2007).

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).

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

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

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

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Schneider Electric; Square D Products: www.schneider-electric.us.

B. Siemens Industry, Inc: www.sea.siemens.com.

C. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

D. ABB.

2.2 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break, enclosed safety switches complying with applicable NEMA ratings, type HD (heavy duty), and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:

G. Provide with switch blade contact position that is visible when the cover is open.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

J. Enclosures: Comply with NEMA KS 1 and NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

L. Heavy Duty Switches:

1. Conductor Terminations:
   a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

2.3 COMPONENTS

A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.

1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
2. Handle lockable in OFF position.
3. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.

1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
2. Handle lockable in OFF position.

C. Enclosures: NEMA KS 1.

1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosed switches in accordance with manufacturer's instructions.

B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 0529.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Provide identification nameplate for each enclosed switch in accordance with Section 26 0553.

I. Provide arc flash warning labels in accordance with NFPA 70.

J. Install fuses in fusible disconnect switches.

K. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

END OF SECTION 26 2818

SECTION 26 3213 - ENGINE GENERATORS (ALTERNATE)

PART 1 GENERAL

1.1 SYSTEM SUMMARY

A. The level 1 emergency power source (EPS) shall consist of (1) packaged 40KW diesel fired generator. Separate feeds shall go to their respective transfer switches consisting of (2) life safety switche. The Life safety switches shall transfer as soon as EPS power is available. The equipment switch shall delay for five minutes and then transfer. The life safety branches shall not be shed.

1.2 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:

1. Engine and engine accessory equipment.
2. Alternator (generator).
3. Generator set control system.
4. Generator set enclosure.

B. Exhaust silencer and fittings.

C. Fuel fittings and day tank.

D. Fuel tank.

E. Battery and charger.

F. Weatherproof enclosure.

1.3 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 263600 - Transfer Switches.

1.4 REFERENCE STANDARDS

A. ASTM D975 - Standard Specification for Diesel Fuel Oils; 2013.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA/EGSA 404 - Standard for Installing Generator Sets; National Electrical Contractors Association; 2007.

D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

F. NFPA 30 - Flammable and Combustible Liquids Code; National Fire Protection Association; 2012.

G. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2010.

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

I. NFPA 99 - Health Care Facilities Code; National Fire Protection Association; 2012.

J. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2013.

K. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

L. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

M. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
   a. Transfer Switches: See Section 263600.
2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.6 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities,

engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.

1. Include generator set sound level test data.
2. Include characteristic trip curves for overcurrent protective devices.
3. Include alternator thermal damage curve.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

E. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

F. Specimen Warranty: Submit sample of manufacturer's warranty.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer's factory emissions certification.

K. Manufacturer's certification that products meet or exceed specified requirements.

L. Source quality control test reports.

M. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:

1. Certified prototype tests.
2. Torsional vibration compatibility certification.
3. NFPA 110 compliance certification.
4. Certified rated load test at rated power factor.

N. Manufacturer’s detailed field testing procedures.

O. Field quality control test reports.

P. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

Q. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

R. Maintenance contracts.

S. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

T. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Filter Elements: Three of each type, including fuel, oil and air.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70 (National Electrical Code).
2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
4. NFPA 30 (Flammable and Combustible Liquids Code).

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience. Provide at minimum, references for five completed installations with similar installations at least one year completed.

1. Authorized service facilities located within 100 miles of project site.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

D. Products: Listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.

E. Conform to requirements of NFPA 70.

1. Maintain one copy of each document on site.

F. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.

G. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

H. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.9 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. Provide minimum five year comprehensive (including labor and parts) (Revision 2) manufacturer warranty covering repair or replacement due to defective materials or workmanship.

C. Accept unit on site on skids. Inspect for damage.

D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Packaged Engine Generator Set - Basis of Design: MTU Onsite Energy

B. Substitutions:

1. Kohler
2. Cummins
3. CAT
4. Generac
5. See Section 016000 - Product Requirements.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

2.2 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description:

1. Application: Emergency/standby.
2. Configuration: Single packaged engine generator set operated in parallel.
3. Total System Power Rating: 40 kW, 50kVA standby.

C. Packaged Engine Generator Set:

1. Type: Diesel (compression ignition).
2. Basis of Design: MTU Onsite Energy
3. Voltage: 208Y/120 V, 3 phase, 60 Hz.

D. Generator Set General Requirements:

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

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

1. Altitude: 500 feet.
2. Ambient Temperature: Between 0 and 104 degrees F.

F. Unit Controller:

1. Provide Overload protection from Unit Controller. Unit shall not depend on circuit breakers or fuses for overload protection.

G. Starting and Load Acceptance Requirements:

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

H. Exhaust Emissions Requirements:

1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:

1. Do not exceed 75 dBA when measured at 23 feet from generator set in free field (no sound barriers) while operating at full load; include manufacturer's sound data with submittals.
2. Comply with applicable noise level regulations.
   a. Do not exceed 50 dBA when measured at property line.

J. Interface with building automation system.

2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

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

B. Engine Fuel System - Diesel (Compression Ignition):

1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
2. Fuel Storage: Sub-base fuel tank.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
5. Sub-Base Fuel Tank:
   a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
   b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
   c. Features:
      1) Direct reading fuel level gauge.
      2) Normal atmospheric vent.
      3) Emergency pressure relief vent.
      4) Fuel fill opening with lockable cap.
      5) Dedicated electrical conduit stub-up area.

C. Engine Starting System:

1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
   a. Battery Type: Lead-acid.
   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.

3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
   c. Recognized as complying with UL 1236.
   d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
   e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
   f. Provide alarm output contacts as necessary for alarm indications.
5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):

1. Multiple Engine Generator Sets Operated in Parallel: Provide electronic isochronous governors with automatic load sharing controls.
2. Generator Sets Used with Closed Transition Transfer Switches: Provide electronic isochronous governor with frequency regulation suitable for transfer.
3. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:

1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:

1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide hospital grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

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

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

J. Fuel System: No. 2 fuel oil.

K. Engine speed: 1800 rpm.

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

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

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

O. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.-

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

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

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

S. Block Heater: Provide Block Heater sized per factory recommendations for worst case ambient temperatures.

T. Accessory Panel: Provide a 120/208V 3-Phase Accessory Panel Prewired from the factory for all unit mounted accessories (lighting, heaters, etc,)

2.4 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.5 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:

1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
2. Generator Set Control Functions:
   a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
   b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
   c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
   d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
   e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
   f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
   g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
3. Generator Set Status Indications:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (W/kW).
   e. Reactive power (VAR/kVAR).
   f. Apparent power (VA/kVA).
   g. Power factor.
   h. Duty Level: Actual load as percentage of rated power.
   i. Engine speed (RPM).

j. Battery voltage (Volts DC).
k. Engine oil pressure.
l. Engine coolant temperature.
m. Engine run time.
n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:
   a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
      1) Overcrank (shutdown).
      2) Low coolant temperature (warning).
      3) High coolant temperature (warning).
      4) High coolant temperature (shutdown).
      5) Low oil pressure (warning).
      6) Low oil pressure (shutdown).
      7) Overspeed (shutdown).
      8) Low fuel level (warning).
      9) Low coolant level (warning/shutdown).
      10) Generator control not in automatic mode (warning).
      11) High battery voltage (warning).
      12) Low cranking voltage (warning).
      13) Low battery voltage (warning).
      14) Battery charger failure (warning).
   b. In addition to NFPA 110 requirements, provide the following protections/indications:
      1) High AC voltage (shutdown).
      2) Low AC voltage (shutdown).
      3) High frequency (shutdown).
      4) Low frequency (shutdown).
      5) Overcurrent (shutdown).
      6) Fuel tank leak (warning), where applicable.
      7) E-Stop Activated (Warning)
      8) Ground Fault Paralleling Gear (Warning)
   c. Provide contacts for local and remote common alarm.
   d. Provide lamp test function that illuminates all indicator lamps.
5. Other Control Panel Features:
   a. Event log.
   b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
   c. Remote monitoring capability via PC.
6. E-Stop Monitoring:
   a. Provide dry-type 2-pole E-Stop shutdown contact within control panel. One contact of the 2-pole contact shall initiate engine stop directly to CPU. The other pole of the contact shall be made available for remote monitoring by building fire alarm system. No other contacts or controls shall be inline from this contact to the Control Panel CPU. The 2-pole contact must be on the same mechanical shaft such that both contacts open and close together

without possibility of the CPU receiving an E-stop signal but the remote fire alarm monitoring relay getting “hung up” and not receiving the same signal.

7. Ground Fault Monitoring from Paralleling Gear:
   a. Provide monitoring and annunciation of ground fault signals received from the Paralleling gear.
8. E-Stop Monitoring from Paralleling Gear:
   a. Provide monitoring and annunciation of E-Stop activation received from the Paralleling gear.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Generator Set Status Indications:
   a. Generator powering load (via position signal from transfer switch).
   b. Communication functional.
3. Generator Set Warning/Shutdown Indications:
   a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
      1) Overcrank (shutdown).
      2) Low coolant temperature (warning).
      3) High coolant temperature (warning).
      4) High coolant temperature (shutdown).
      5) Low oil pressure (warning).
      6) Low oil pressure (shutdown).
      7) Overspeed (shutdown).
      8) Low fuel level (warning).
      9) Low coolant level (warning/shutdown).
      10) Generator control not in automatic mode (warning).
      11) High battery voltage (warning).
      12) Low cranking voltage (warning).
      13) Low battery voltage (warning).
      14) Battery charger failure (warning).
      15) E-Stop Activated (Warning)
      16) Ground Fault Paralleling Gear (Warning)
   b. Provide audible alarm with silence function.
   c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.7 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating level 2, weather protective.

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Custom color to be selected by Architect.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.

I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

J. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

2.8 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

C. Generator Set production testing to include, at a minimum:

1. Operation at rated load and rated power factor.
2. Single step load pick-up.
3. Transient and steady state voltage and frequency performance.
4. Operation of safety shutdowns.

D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

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

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 033000. Provide suitable vibration isolators, where not factory installed.

F. Provide required support and attachment in accordance with Section 260529.

G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Provide diesel fuel piping and venting in accordance with Section 232113, where not factory installed.

I. Provide engine exhaust piping in accordance with Section 235100, where not factory installed.

1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
2. Do not exceed manufacturer's maximum back pressure requirements.

J. Install exhaust silencer in accordance with Section 235100, where not factory installed.

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

L. Identify system wiring and components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, at a minimum:

1. Inspect each system component for damage and defects.
2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
3. Check for proper oil and coolant levels.

G. Prepare and start system in accordance with manufacturer's instructions.

H. Perform acceptance test in accordance with NFPA 110.

I. Inspection and testing to include, at a minimum:

1. Verify compliance with starting and load acceptance requirements.
2. Verify voltage and frequency; make required adjustments as necessary.
3. Verify phase sequence.
4. Verify control system operation, including safety shutdowns.
5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
6. Perform load tests in accordance with NFPA 110 (4 hour building load test followed by 4 hour full load test).

J. Provide field emissions testing where necessary for certification.

K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.

L. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

N. Provide the services of manufacturer's representative to prepare and start system.

O. Perform field inspection and testing in accordance with Section 014000.

P. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal.

Q. Record in 20 minute intervals during four hour test:

1. Kilowatts.
2. Amperes.
3. Voltage.
4. Coolant temperature.
5. Frequency.
6. Oil pressure.

R. Test alarm and shutdown circuits by simulating conditions.

3.4 ADJUSTING

A. Adjust generator output voltage and engine speed.

3.5 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

D. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters.

3.7 PROTECTION

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

3.8 MAINTENANCE

A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner at no extra cost, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

END OF SECTION 26 3213

SECTION 26 3213 - ENGINE GENERATORS

PART 1 GENERAL

1.1 SYSTEM SUMMARY

A. The level 1 emergency power source (EPS) shall consist of (1) packaged 750KW diesel fired generator. Separate feeds shall go to their respective transfer switches consisting of (2) life safety switches and (1) equipment switch. The Life safety switches shall transfer as soon as EPS power is available. The equipment switch shall delay for five minutes and then transfer. Upon reaching 85% loading the EPS shall shed the equipment branch. The life safety branches shall not be shed.

1.2 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:

1. Engine and engine accessory equipment.
2. Alternator (generator).
3. Generator set control system.
4. Generator set enclosure.

B. Exhaust silencer and fittings.

C. Fuel fittings and day tank.

D. Fuel tank.

E. Battery and charger.

F. Weatherproof enclosure.

1.3 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 263600 - Transfer Switches.

1.4 REFERENCE STANDARDS

A. ASTM D975 - Standard Specification for Diesel Fuel Oils; 2013.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA/EGSA 404 - Standard for Installing Generator Sets; National Electrical Contractors Association; 2007.

D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

F. NFPA 30 - Flammable and Combustible Liquids Code; National Fire Protection Association; 2012.

G. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2010.

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

I. NFPA 99 - Health Care Facilities Code; National Fire Protection Association; 2012.

J. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2013.

K. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

L. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

M. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
   a. Transfer Switches: See Section 263600.
2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.6 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service

condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.

1. Include generator set sound level test data.
2. Include characteristic trip curves for overcurrent protective devices.
3. Include alternator thermal damage curve.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

E. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

F. Specimen Warranty: Submit sample of manufacturer's warranty.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer's factory emissions certification.

K. Manufacturer's certification that products meet or exceed specified requirements.

L. Source quality control test reports.

M. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:

1. Certified prototype tests.
2. Torsional vibration compatibility certification.
3. NFPA 110 compliance certification.
4. Certified rated load test at rated power factor.

N. Manufacturer’s detailed field testing procedures.

O. Field quality control test reports.

P. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

Q. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

R. Maintenance contracts.

S. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

T. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Filter Elements: Three of each type, including fuel, oil and air.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70 (National Electrical Code).
2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
4. NFPA 30 (Flammable and Combustible Liquids Code).

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience. Provide at minimum, references for five completed installations with similar installations at least one year completed.

1. Authorized service facilities located within 100 miles of project site.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

D. Products: Listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.

E. Conform to requirements of NFPA 70.

1. Maintain one copy of each document on site.

F. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.

G. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

H. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.9 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. Provide minimum five year comprehensive (including labor and parts) (Revision 2) manufacturer warranty covering repair or replacement due to defective materials or workmanship.

C. Accept unit on site on skids. Inspect for damage.

D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Packaged Engine Generator Set - Basis of Design: MTU Onsite Energy

B. Substitutions:

1. Kohler
2. Cummins
3. CAT
4. Generac
5. See Section 016000 - Product Requirements.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

2.2 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description:

1. Application: Emergency/standby.
2. Configuration: Single packaged engine generator set operated in parallel.
3. Total System Power Rating: 750 kW, 938kVA standby.

C. Packaged Engine Generator Set:

1. Type: Diesel (compression ignition).
2. Basis of Design: MTU Onsite Energy
3. Voltage: 208Y/120 V, 3 phase, 60 Hz.

D. Generator Set General Requirements:

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

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

1. Altitude: 500 feet.
2. Ambient Temperature: Between 0 and 104 degrees F.

F. Unit Controller:

1. Provide Overload protection from Unit Controller. Unit shall not depend on circuit breakers or fuses for overload protection.

G. Starting and Load Acceptance Requirements:

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

H. Exhaust Emissions Requirements:

1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:

1. Do not exceed 75 dBA when measured at 23 feet from generator set in free field (no sound barriers) while operating at full load; include manufacturer's sound data with submittals.
2. Comply with applicable noise level regulations.
   a. Do not exceed 50 dBA when measured at property line.

J. Interface with building automation system.

2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

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

B. Engine Fuel System - Diesel (Compression Ignition):

1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
2. Fuel Storage: Sub-base fuel tank.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
5. Sub-Base Fuel Tank:
   a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
   b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
   c. Features:
      1) Direct reading fuel level gauge.
      2) Normal atmospheric vent.
      3) Emergency pressure relief vent.
      4) Fuel fill opening with lockable cap.
      5) Dedicated electrical conduit stub-up area.

C. Engine Starting System:

1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
   a. Battery Type: Lead-acid.
   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.

3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
   c. Recognized as complying with UL 1236.
   d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
   e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
   f. Provide alarm output contacts as necessary for alarm indications.
5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):

1. Multiple Engine Generator Sets Operated in Parallel: Provide electronic isochronous governors with automatic load sharing controls.
2. Generator Sets Used with Closed Transition Transfer Switches: Provide electronic isochronous governor with frequency regulation suitable for transfer.
3. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:

1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:

1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide hospital grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

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

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

J. Fuel System: No. 2 fuel oil.

K. Engine speed: 1800 rpm.

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

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

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

O. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.-

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

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

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

S. Block Heater: Provide Block Heater sized per factory recommendations for worst case ambient temperatures.

T. Accessory Panel: Provide a 120/208V 3-Phase Accessory Panel Prewired from the factory for all unit mounted accessories (lighting, heaters, etc,)

2.4 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.5 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:

1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
2. Generator Set Control Functions:
   a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
   b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
   c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
   d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
   e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
   f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
   g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
3. Generator Set Status Indications:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (W/kW).
   e. Reactive power (VAR/kVAR).
   f. Apparent power (VA/kVA).
   g. Power factor.
   h. Duty Level: Actual load as percentage of rated power.
   i. Engine speed (RPM).

j. Battery voltage (Volts DC).
k. Engine oil pressure.
l. Engine coolant temperature.
m. Engine run time.
n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:
   a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
      1) Overcrank (shutdown).
      2) Low coolant temperature (warning).
      3) High coolant temperature (warning).
      4) High coolant temperature (shutdown).
      5) Low oil pressure (warning).
      6) Low oil pressure (shutdown).
      7) Overspeed (shutdown).
      8) Low fuel level (warning).
      9) Low coolant level (warning/shutdown).
      10) Generator control not in automatic mode (warning).
      11) High battery voltage (warning).
      12) Low cranking voltage (warning).
      13) Low battery voltage (warning).
      14) Battery charger failure (warning).
   b. In addition to NFPA 110 requirements, provide the following protections/indications:
      1) High AC voltage (shutdown).
      2) Low AC voltage (shutdown).
      3) High frequency (shutdown).
      4) Low frequency (shutdown).
      5) Overcurrent (shutdown).
      6) Fuel tank leak (warning), where applicable.
      7) E-Stop Activated (Warning)
      8) Ground Fault Paralleling Gear (Warning)
   c. Provide contacts for local and remote common alarm.
   d. Provide lamp test function that illuminates all indicator lamps.
5. Other Control Panel Features:
   a. Event log.
   b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
   c. Remote monitoring capability via PC.
6. E-Stop Monitoring:
   a. Provide dry-type 2-pole E-Stop shutdown contact within control panel. One contact of the 2-pole contact shall initiate engine stop directly to CPU. The other pole of the contact shall be made available for remote monitoring by building fire alarm system. No other contacts or controls shall be inline from this contact to the Control Panel CPU. The 2-pole contact must be on the same mechanical shaft such that both contacts open and close together

without possibility of the CPU receiving an E-stop signal but the remote fire alarm monitoring relay getting “hung up” and not receiving the same signal.

7. Ground Fault Monitoring from Paralleling Gear:
   a. Provide monitoring and annunciation of ground fault signals received from the Paralleling gear.
8. E-Stop Monitoring from Paralleling Gear:
   a. Provide monitoring and annunciation of E-Stop activation received from the Paralleling gear.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Generator Set Status Indications:
   a. Generator powering load (via position signal from transfer switch).
   b. Communication functional.
3. Generator Set Warning/Shutdown Indications:
   a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
      1) Overcrank (shutdown).
      2) Low coolant temperature (warning).
      3) High coolant temperature (warning).
      4) High coolant temperature (shutdown).
      5) Low oil pressure (warning).
      6) Low oil pressure (shutdown).
      7) Overspeed (shutdown).
      8) Low fuel level (warning).
      9) Low coolant level (warning/shutdown).
      10) Generator control not in automatic mode (warning).
      11) High battery voltage (warning).
      12) Low cranking voltage (warning).
      13) Low battery voltage (warning).
      14) Battery charger failure (warning).
      15) E-Stop Activated (Warning)
      16) Ground Fault Paralleling Gear (Warning)
   b. Provide audible alarm with silence function.
   c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.7 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating level 2, weather protective.

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Custom color to be selected by Architect.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.

I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

J. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature. (Revision 2)

2.8 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

C. Generator Set production testing to include, at a minimum:

1. Operation at rated load and rated power factor.
2. Single step load pick-up.
3. Transient and steady state voltage and frequency performance.
4. Operation of safety shutdowns.

D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

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

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 033000. Provide suitable vibration isolators, where not factory installed.

F. Provide required support and attachment in accordance with Section 260529.

G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Provide diesel fuel piping and venting in accordance with Section 232113, where not factory installed.

I. Provide engine exhaust piping in accordance with Section 235100, where not factory installed.

1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
2. Do not exceed manufacturer's maximum back pressure requirements.

J. Install exhaust silencer in accordance with Section 235100, where not factory installed.

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

L. Identify system wiring and components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, at a minimum:

1. Inspect each system component for damage and defects.
2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
3. Check for proper oil and coolant levels.

G. Prepare and start system in accordance with manufacturer's instructions.

H. Perform acceptance test in accordance with NFPA 110.

I. Inspection and testing to include, at a minimum:

1. Verify compliance with starting and load acceptance requirements.
2. Verify voltage and frequency; make required adjustments as necessary.
3. Verify phase sequence.
4. Verify control system operation, including safety shutdowns.
5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
6. Perform load tests in accordance with NFPA 110 (4 hour building load test followed by 4 hour full load test).

J. Provide field emissions testing where necessary for certification.

K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.

L. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

N. Provide the services of manufacturer's representative to prepare and start system.

O. Perform field inspection and testing in accordance with Section 014000.

P. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal.

Q. Record in 20 minute intervals during four hour test:

1. Kilowatts.
2. Amperes.
3. Voltage.
4. Coolant temperature.
5. Frequency.
6. Oil pressure.

R. Test alarm and shutdown circuits by simulating conditions.

3.4 ADJUSTING

A. Adjust generator output voltage and engine speed.

3.5 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

D. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters.

3.7 PROTECTION

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

3.8 MAINTENANCE

A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner at no extra cost, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

END OF SECTION 26 3213

SECTION 263600 - TRANSFER SWITCHES

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Automatic Transfer Switches.

B. Manual Transfer switches

1.2 Scope

A. Furnish and install automatic transfer switches (3ATS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of a mechanically held power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation. All transfer switches and control panels shall be the product of the same manufacturer.

1.3 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Housekeeping pads.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 263213 - Engine Generators: Testing requirements.

1.4 REFERENCE STANDARDS

A. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment; National Electrical Manufacturers Association; 2005.

B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

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. UL1008 – Standard for Automatic Transfer Switches

1.5 SUBMITTALS

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

B. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

C. 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.

D. Operation Data: Instructions for operating equipment under emergency conditions when engine generator is running.

E. Maintenance Data: Routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Automatic transfer switches shall be ASCO Series 300 (3ATS). Any alternate shall be submitted to the consulting engineer in writing at least 10 days prior to bid. Each alternate bid must list any deviations from this specification.

1. ATS #1 – Life Safety – Open Transition – 104A – 4 pole – 208V – ASCO 300 series

   a. With 7ES, 11BE, 18RX, and 72EE.

2. ATS #2 – Equipment – Delayed Transition – 3000A – 4 pole – 208V – Nema 3R enclosure - ASCO 300 series

   a. With 7ES, 11BE, 18RX, 30AA, and 72EE.

3. MTQ #1 – 104A – 208V – Nema 3R Enclosure - ASCO 300 series

   a. With 44G, 135L, 170BP1, and 72EE

4. 5101-Gen Kit Start Signal Monitoring

5. 5705 annunciator

2.2 Mechanically Held Transfer Switch

A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include over current disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.

B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

C. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.

D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

F. Where neutral conductors must be switched, the ATS shall be provided with fully-rated neutral transfer contacts.

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

2.3 Group 'G' Controller with Integrated User Interface Panel

A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.

B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via the Ethernet through optional communications module

C. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.1Hz. Time delay settings shall be accurate to ±

0.5% of the full scale value of the time delay. The panel shall be capable of operating over a temperature range of -20 to + 70 degrees C, and storage from -55 to + 85 degrees C.

D. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.

E. The controller shall meet or exceed the requirements for

Electromagnetic

Compatibility (EMC) as follows:

1. IEC 60947 – 6 – 1 Multiple Function Equipment Transfer Switching Equipment.

61000-4 Testing And Measurement Techniques - Overview

a. IEC 61000 – 4 - 2 Electrostatic Discharge

Immunity b. IEC 61000 – 4 - 3 Radiated RF Field

Immunity

c. IEC 61000 – 4 - 4 Electrical Fast Transient/Burst Immunity

d. IEC 61000 – 4 - 5 Surge Immunity

e. IEC 61000 – 4 – 6 Conducted RF Immunity

2. CISPR 11 – Conducted RF Emissions and Radiated RF

Emissions

2.4 Enclosure

A. The 3ATS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.

B. Provide strip heater with thermostat for Type 3R enclosure requirements.

C. Controller shall be mounted on, visible, and operational through enclosure

door.

2.5 Controller Display and Keypad

A. A 128*64 graphical LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters.

Operational parameters shall also be available for viewing and limited control through communications port. The following parameters shall only be adjustable via DIP switches on the controller.

1. Nominal line voltage and frequency

2. Single or three phase sensing on normal

3. Transfer operating mode configuration, (open transition, or delayed transition)

All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.6 Voltage and Frequency Sensing

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup ,dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified.

Parameter	Sources	Dropout/Trip	Pickup/Reset
Undervoltage	N & E	70 to 98%	85 to 100%
Overvoltage	N & E	102 to116%	2% below trip
Underfrequency	N & E	85 to 98%	86 to 100%
Overfrequency	N & E	101 to 111%	2% below trip

B. Repetitive accuracy of all settings shall be within 1% at +25C

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage and frequency. *Note: Single phase sensing on emergency*

E. The backlit 128*64 graphical display shall have multiple language capability.

Languages can be selected from the user interface.

2.7 Time Delays

A. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds. It shall be possible to bypass the time delay from the controller user interface.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface.

C. A generator stabilization time delay shall be provided after transfer to emergency adjustable 0 or 4 seconds.

D. A time delay shall be provided on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.

E. A cooldown time delay shall be provided on shutdown of engine generator, Adjustable 0 to 60 minutes 59 seconds.

F. All adjustable time delays shall be field adjustable without the use of special tools.

G. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes 59 seconds time delay in any of the following modes:

1. Prior to transfer only.

2. Prior to and after transfer.

3. Normal to emergency only.

4. Emergency to normal only.

5. Normal to emergency and emergency to normal.

6. All transfer conditions or only when both sources are available.

H. In the event that the alternate source is not accepted within the configured Failure to Accept time delay, the common alert indication shall become active.

I. The controller shall also include the following built-in time delay for delayed transition operation.

1. A time delay for the load disconnect position for delayed transition operation adjustable 0 to 5 minutes 59 seconds.

2.8 Additional Features

A. The user interface shall be provided with test/reset modes. The test mode will simulate a normal source failure. The reset mode shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A set of contacts rated 5 amps, 30 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down. setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed when the ATS is connected to the emergency source.

D. A single alarm indication shall light up the alert indicator and de – energize the configured common alarm output relay for external monitoring.

E. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

F. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.

G. LED indicating light shall be provided to indicate switch not in automatic mode (manual); and blinking (amber) to indicate transfer inhibit.

H. LED indicating light shall be provided to indicate any alarm condition or active time delay (red).

The following features shall be built – in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:

I. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

J. A variable window inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO feature 27.

K. An engine generator exercising timer shall be provided to configure weekly and bi-weekly automatic testing of an engine generator set with or without load for 20 minutes fixed. It shall be capable of being configured to indicate a day of the week, and time weekly testing should occur.

The following feature shall be built – into the controller, but capable of being activated through keypad programming, communications interface port, or additional hardware.

L. Terminals shall be provided for a remote contact to signal the ATS to transfer to emergency. This inhibit signal can be enabled through the keypad or serial port.

M. System Status - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key. This screen shall display a clear description of the active operating sequences and switch position. For example,

Normal Failed

Load on Normal

TD Normal to Emerg

2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual are not permissible.

N. Self Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

O. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication port with a network of transfer switches, locally (up to 4000 ft.). Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control, and setup of parameters.

P. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non – volatile memory.

1. Event Logging

1. Data and time and reason for transfer normal to emergency
2. Data and time and reason for transfer emergency to normal
3. Data and time and reason for engine start
4. Data and time engine stopped
5. Data and time emergency source available
6. Data and time emergency source not available

2. Statistical Data

1. Total number of transfers
2. Total number of transfers due to source failure
3. Total number of day's controller is energized
4. Total number of hours both normal and emergency sources are Available
5. Total time load is connected to normal
6. Total time load is connected to emergency
7. Last engine start
8. Last engine start up time
9. Input and output status

2.9 Load Shed Circuit (Contact)

For the delayed transition only - A load shed shall be initiated by opening of customer supplied contact to match generator set capacity to the load. Relay de – energization opens emergency contactor (CE) disconnecting the load from the emergency source. If the normal source is acceptable , normal source contactor (CN) is closed to connecting the load to the

normal source. When the load is reconnected to normal the control panel is reset in readiness for the next normal source failure. (This feature shall be equal to ASCO accessory 30AA).

2.10 ATS Remote Annunciator – 5705

General

Provide and install ATS Remote Annunciators for monitoring and control of automatic transfer switches remotely over Ethernet.

A. Hardware Specifications

The ATS Remote Annunciator shall be listed to cUL-60950-1 and UL 1008 and include the following features and ratings:

- User-configured labels with ATS names and power sources
- Dual 1*0/100 Base-T auto sensing and auto crossover Ethernet ports*
- LED indication of source acceptability, switch position, common alarm, time delay and Ethernet link activity
- Push button for transfer/retransfer control operations and time delay bypass
- *Push buttons for Alarm Silence and Lamp Test*
- Key lock to enable and disable the transfer push button
- Audible and visual alarm to indicate Communication Error ATS Locked Out Failure to Synchronize Extended Parallel and any of the 8 user-configured discrete inputs
- *Programmable watchdog timer that can generate a system reset upon timeout (minimum 1 sec)*
- *Factory reset capability*
- *100 ms power ride-through*

B. Software Specification

The ATS Remote Annunciator shall contain embedded web pages accessible via various web browsers with the following capabilities:

- Configuration for protocol and communications management with the ability of auto discovering transfer switches on network
- Ability to create and print customized labels for ATS names and power sources
- The ability to choose a continuous or periodic audible alarm with customizable interval time
- View detailed packet status counters i.e. transmitted received and dropped packets with the ability to reset counters
- ATS source name configuration page which allows users to configure power source names and print labels
- Upgrade firmware from Ethernet network without interrupting equipment operation

C. Communications

Dual 10/100 Base-T (RJ-45) Ethernet ports are provided to support TCP/IP communications for up to eight automatic transfer switches via individual remote connectivity modules or daisy-chained serial modules into a single Connectivity Module. Additional features include:

- *Supports Full Duplex Flow Control (IEEE 802.3x)*
- *3.3V power supply with 5V I/O tolerance*
- *Supports 3 LEDs to indicate traffic link speed and collision*

D. Mounting

The ATS Remote Annunciator is suitable for:

- *Surface mounting using mounting screws studs*
- *Flush Mount from behind a cutout section (Enclosure Door Mounting)*
- *Flush Mount from the front of a cutout section (Enclosure Door Mounting)*

E. Power Supply

The ATS Remote Annunciator shall be capable of accepting 24VDC, 120 VAC or 240 VAC power source.

F. Environmental

The ATS Remote Annunciator shall have an Ambient Operating Temperature range of -4 º to 158 º F (-20 º to +70 º C) @ 5~85% humidity and Ambient Storage Temperature of -40 º to 185 º F (-40 º to 85 º C).

2.11 Withstand and Closing Ratings

A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans. WCR ATS ratings shall be as follows when used with specific circuit breakers:

ATS Size	Withstand & Closing Rating MCCB (480v/60hz)	W/CLF
30	22,000A	100,000
70 - 200	22,000A	200,000
230	25,000A	100,000
260 – 400	42,000A	200,000
600	50,000A	200,000
800 – 1200	65,000A	200,000
1600 – 2000	85,000A	200,000
2600 – 3000	100,000A	200,000

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surface is suitable for transfer switch installation.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Identify transfer switches in accordance with Section 260553.

C. Provide engraved plastic nameplates under the provisions of Section 260553.

3.3 FIELD QUALITY CONTROL

A. Provide the services of the manufacturer's technical representative to check out transfer switch connections and operation and place in service.

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. Perform inspections and tests listed in NETA STD ATS, Section 7.22.3.

3.4 CLOSEOUT ACTIVITIES

A. Demonstrate operation of transfer switch in bypass, normal, and emergency modes.

3.5 MAINTENANCE

A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide a separate maintenance contract for specified maintenance service.

C. Provide service and maintenance of transfer switches for one year from Date of Substantial Completion.

END OF SECTION
263600

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SECTION 26 4300 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

B. Surge protective devices for distribution locations.

C. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 262300 - Low-Voltage Switchgear.

C. Section 262413 - Switchboards.

D. Section 262416 - Panelboards.

E. Section 271000 - Structured Cabling: Protectors for communications service entrance.

1.3 ABBREVIATIONS AND ACRONYMS

A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.

B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

A. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2014).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

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

F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.6 SUBMITTALS

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

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
   1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
   1. UL 1449.
   2. UL 1283 (for Type 2 SPDs).

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

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

B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Leviton.

B. Field-installed, Externally Mounted Surge Protective Devices - Other Acceptable Manufacturers:
1. Advanced Protection Technologies, Inc (APT); _____: www.aptsurge.com/#sle.
2. Hubbel.
3. SSI

C. Factory-installed, Internally Mounted Surge Protective Devices:
1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

D. Substitutions: See Section 016000 - Product Requirements.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mouonted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:
   1. Wye Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):
   1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
   2. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   1. Indoor clean, dry locations: Type 1.
   2. Outdoor locations: Type 3R.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
   1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
   2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
   1. Switchgear: See Section 262300.
   2. Switchboards: See Section 262413.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:
   1. Protection Circuits: Field-replaceable modular or non-modular.
   2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
   3. UL 1449 Nominal Discharge Current (I-n): 20 kA.

4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
6. Diagnostics:
   a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
   d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.4 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards, motor control centers, and busway.

B. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
   a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
   a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
   b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
   d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.5 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:
   1. Protection Circuits: Field-replaceable modular or non-modular.
   2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
   3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
   4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
   5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
      a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
   6. Diagnostics:
      a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
      b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
      c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
      d. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
   7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

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 26 4300

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SECTION 26 5100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 PROJECT INCLUDES

A. Interior luminaires.

B. Ballasts.

C. Lamps.

D. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 260537 - Boxes.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 260918 - Remote Control Switching Devices: Remote controls for lighting, including remote control switching relays.

D. Section 260919 - Enclosed Contactors: Lighting contactors.

E. Section 260923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.

F. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.

G. Section 265600 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type); 2002.

B. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; Consolidated-2002.

C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (R2008).

D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002.

E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.

F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.

H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2006.

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

J. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.

K. UL 1029 - High-Intensity-Discharge Lamp Ballasts; Current Edition, Including All Revisions.

L. UL 1598 - Luminaires; Current Edition, Including All Revisions.

M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

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

B. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
2. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
3. LED emitters and drivers: Include rated life, color temperature, lumen output of system.

D. Certificates for Dimming Ballasts and Drivers: Manufacturer's documentation of compatibility with dimming controls to be installed. **The EC shall be responsible for providing and installing all required wiring for control of 0-10v dimming systems.**

E. Field Quality Control Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.

I. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 70 and NFPA 101.

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

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturers required service conditions during and after installation.

1.9 WARRANTY

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

B. Provide two year manufacturer warranty for all linear fluorescent ballasts.

C. Provide minimum five year warranty for LED drivers.

D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

B. Substitutions: See Section 016000 - Product Requirements.

1. Alternates must be submitted 10 days prior to bid date for approval. Submission does not guarantee approval. If the Contractor obtains approvals and decides to proceed with the Alternate fixtures, the Contractor shall be responsible for verifying the circuiting is adequate and make any necessary changes to accommodate the new fixtures and the Contractor shall be responsible for the recalculation of Comcheck.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, drivers, reflectors, lenses, housings, mounting accessories and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires: Listed and labeled as complying with UL 8750. Provide LED Drivers with the luminaire as a complete package.

2.4 LAMPS

A. Manufacturers:

1. Refer to Luminaire Fixture Schedule on the drawings
   a. Substitutions: See Section 016000 - Product Requirements.
   b. Manufacturer Limitations: Where possible, provide lamps produced by a single manufacturer.
   c. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.

B. All Lamps:

1. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
2. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Ceiling Mounted Luminaires:

1. Do not use ceiling tiles to bear weight of luminaires.
2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members, or to building structure.
4. Secure pendant-mounted luminaires to building structure.
5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.

6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
7. Provide steel cable support from opposing corners to structure above in addition to the safety clips provided with the luminaire.

F. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.
5. Unless otherwise indicated, support pendants from swivel hangers.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

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

J. Install lamps in each luminaire.

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

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 5100

SECTION 27 1005 - STRUCTURED CABLING FOR VOICE AND DATA - OUTSIDE PLANT AND INSIDE PLANT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Telecommunications service entrance to building(s).

B. Cabling and pathways inside building(s).

C. Cabling and pathways connecting building(s).

D. Distribution frames, cross-connection equipment, enclosures, and outlets.

E. Grounding and bonding the telecommunications distribution system.

1.2 RELATED REQUIREMENTS

A. Section 337119 - Electrical Underground Ducts and Manholes.

B. Section 078400 - Firestopping.

C. Section 260526 - Grounding and Bonding for Electrical Systems: Electrical system grounding and bonding.

D. Section 260534 - Conduit.

E. Section 260536 - Cable Trays for Electrical Systems.

F. Section 260537 - Boxes.

G. Section 262726 - Wiring Devices.

1.3 REFERENCE STANDARDS

A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.

B. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.

C. ICEA S-90-661 - Category 3, 5, 5e, 6 and 6A Individually Unshielded Twisted Pair Indoor Cable for Use in General Purpose and LAN Communications Wiring Systems; Insulated Cable Engineers Association; 2002.

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

E. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 2012.

F. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.

G. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (R 2002).

H. TIA-526-7 - OFSTP-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; 2002.

I. TIA-526-14 - OFSTP-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Rev B, 2010.

J. TIA/EIA-568-C.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev C, 2012; Addenda 1-7.

K. TIA/EIA-568-C.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Rev C, 2012; Addenda 1-11.

L. TIA/EIA-568-C.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 C, 2012; Addendum 1.

M. TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces; 2012.

N. TIA-570 - Residential Telecommunications Infrastructure Standard; 2009.

O. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev B, 2012.

P. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.

Q. UL 444 - Communications Cables; Current Edition, Including All Revisions.

R. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; Current

Edition, Including All Revisions.

S. UL 1863 - Standard for Communications-Circuit Accessories; Current Edition, Including All Revisions.

T. USDA RUS 345-83 - Gas Tube Surge Arrestors (PE-80); US Department of Agriculture; 1982.

1.4 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Storage and handling requirements and recommendations.
   2. Installation methods.

C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).

D. Manufacturer Qualifications.

E. Installer Qualifications.

F. Field Test Reports.

G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   1. Record actual locations of outlet boxes and distribution frames.
   2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
   3. Identify distribution frames and equipment rooms by room number on contract drawings.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 3 years' experience manufacturing products of the type specified.

B. Installer Qualifications: A company having at least 3 years' experience in the installation and testing of the type of system specified, and:
   1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
   2. Supervisors and installers factory certified by manufacturers of products to be installed.

3. 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 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a 15 week period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cabling and Equipment:

B. Hubbell Premise Wiring
   1. Substitutions:
      a. Systimax GigaSpeed solution (no uniprise)
      b. See Section 260100 - Product Requirements.
      c. Substitutions require 30-day pre-approval

2.2 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA/EIA-568 and TIA/EIA-569, latest editions.
   2. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
   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.

B. Capacity:
   1. Horizontal Cabling
      a. MDF to IDF's
         1) Armored 12 strand single mode indoor/outdoor rated(OS2) fiber optic. Hubbell PN# HFCD190012PSBK and 12 strand multi mode armored (OM4) fiber optic. Hubbell PN # HFC190012P4BK
         2) Number of outlets:
            (a) Classrooms: Refer to the drawings for exact counts of ports. Contractor shall calculate based on floor plans.
            (b) Refer to floor plans for Wi-Fi locations (2 drops per location).
            (c) Refer to floor plans for Camera locations (2 drops per location).
            (c) Provide additional outlets where indicated on drawings.

C. Main Distribution Frame (MDF): MDF as support structure for terminating backbone cables, functioning as point of presence to external service provider.
   1. Located as indicated on the drawings.
   2. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
   3. Provide new 2-post racks. Hubbell PN#HPW84RR19D Series
   4. Provide cable Managers per 2 post frame. Hubbell PN#VMVM813
   5. Provide PDU's for each 2-post rack Great Lakes cat# GL7352D

D. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to data and telecommunications outlets.
   1. Locate intermediate distribution frames as indicated on the drawings.
   2. Provide wall mounted racks Hubbell PN#HSQ48
   3. Provide cable management Hubbell PN#HM14C and Hubbell PN#HM24C
   4. Provide PDU's for each rack Great Lakes cat# GL7352D

E. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.

F. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.3 PATHWAYS

A. Conduit: As specified in Section 260534; provide pull cords in all conduit.

B. Cable Trays: As specified in Section 260536.

2.4 COPPER CABLE AND TERMINATIONS

A. Copper Horizontal Cable: TIA/EIA-568 Category 6A, (.260 OD) solid conductor unshielded twisted pair (UTP), 23 AWG, 100 ohm; 4 individually twisted pairs; covered with blue jacket and complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444.
   1. In plenums, provide NFPA 70 type CMP plenum-rated cable, Hubbell PN#C6ASPDSB
   2. Testing: Furnish factory reel tests.

B. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

C. Jacks and Connectors: RJ-45, angled, non-keyed, terminated with 110-style insulation displacement connectors; high impact thermoplastic housing; complying with same standard as specified horizontal cable and UL 1863. Hubbell PN# HJU6Axx
   1. Performance: 500 mating cycles.
   2. Voice and Data Jacks: 4-pair, pre-wired to T568A configuration, with color-coded indications for T568B configuration.

D. Copper Backbone Cable: TIA/EIA-568 Category 5e solid conductor unshielded twisted pair (UTP), 24 AWG, 100 ohm; 25 pair; covered with gray thermoplastic jacket and complying with all relevant parts of and addenda to latest editions of TIA/EIA-568 and ICEA S-90-661, and UL 444. Cable shall be Mohawk #M58142. Terminate copper backbone cables on Cat 5e patch panels in the network rack.
   1. In plenums, provide NFPA 70 type CMP plenum-rated cable.
   2. Provide cable having conductors twisted at minimum rate of two per foot; actual length and frequency of twists at manufacturer's option.
   3. Color code conductors in accordance with ICEA S-90-661.
   4. Testing: Furnish factory reel tests.

2.5 FIBER OPTIC CABLE AND ADAPTORS

A. Fiber Optic Backbone Cable: 12-fiber, Armored I/O OS2 single mode 8/125 um, complying with TIA-492CAAA; covered with yellow cable jacket and complying with relevant portions of and addenda to latest edition of TIA/EIA-568. PN#HFCD190xxPSBK

B. Fiber Optic Backbone Cable: 12-fiber, armored I/O OM4 multimode 50/125 um, complying with TIA-492AAAB; covered with aqua cable jacket and complying with relevant portions of and addenda to latest edition of TIA/EIA-568. PN#HFCD190xxP4BK

B. Fiber Patch Cords shall be Hubbell #DFPCLCLCFEMM & DFPCLCLCS3SM, 3 meter length.

C. Fiber Enclosures shall be Hubbell #FCR2U9SP, with FSPLCDS6 Duplex MM Adapter Panels, #FCLC900K50GM12 & FCLC900KSM12 SM and MM connectors.

D. Fiber Optic Adapters and Connectors: Duplex LC, push-on-push-off type, multimode adaptors with zirconia ceramic alignment sleeves; complying with relevant parts and addenda to latest edition of TIA/EIA-568 and with maximum attenuation of 0.3 dB at 1300 nm with less than 0.2 dB change after 500 mating cycles when tested in accordance with TIA-455-21.

2.6 CROSS-CONNECTION EQUIPMENT

A. Connector Blocks for Category 6A and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.

B. Patch Panels for Copper Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface. Provide Hubbell #HPJ6A48, Comes with Rear management bar
1. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
2. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
3. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
4. Provide incoming cable strain relief and routing guides on back of panel.
5. Patch Cords: Provide one patch cord for each pair of patch panel ports.
   a. Patch Cords shall be Hubbell #HC6Axxyy ten feet in length.
6. Manufacturer's patch cords must be used to provide a Channel Warranty
7. Category 6A panels shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568.2-D, Transmission Performance specifications for 4-pair 100 OHM cat 6A cabling systems
8. Panels shall be tested to 150% of IEEE 802.3bt DTE Power specification with no degradation of performance or materials
9. Stainless steel face plates must be used. Hubbell SSFL series

C. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
1. Adaptors: As specified above under FIBER OPTIC CABLING; maximum of 24 duplex adaptors per standard panel width.
2. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
3. Provide incoming cable strain relief and routing guides on back of panel.
4. Provide rear cable management tray at least 8 inches deep with removable cover.
5. Provide dust covers for unused adaptors.
6. Patch Cords: Provide one patch cord for each pair of patch panel ports.

2.7 ENCLOSURES

A. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.

1. Size: 96 inches wide by 96 inches high.
2. Do not paint over UL label.

B. Server Cabinets: CEA-310 standard 700-millimeter-wide component racks.
1. Floor Mounted Cabinet: 16 gauge steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, PDU channel, and grounding lug. Provide Great Lakes PN# GL840ES-3048MSS
2. Provide Vertical and HZ cable management PN#VCM-84K, Horizontal PN#CM-17.

C. Equipment Racks and Cabinets: CEA-310 standard 19 inch wide component racks.
1. Floor Mounted Racks: 16 gage steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug. Provide Great Lakes PN#VRX-45U2436 with PN#VRX-CMU and #VRXK145U, Horizontal managers PN#CM-17.

D. Building Entrance Protector: Factory fabricated panel to connect incoming cable and interior cable to protector modules.
1. Capacity: One protector module per pair in incoming cable.
2. Protector Modules: Type rated for the application.
   a. Solid State Type: Complying with UL 497.
3. Incoming Side: Provide connector blocks of type specified.
4. Outgoing Side (to Interior): Backbone cable wired to connector blocks.

E. Outlet Boxes: For flush mounting in walls; depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
1. Size, Unless Otherwise Indicated: 4 inches square by 2-1/8 inches deep.
2. Wall-Mounted Telephones: 4 inches high by 2 inches wide by 2-1/8 inches deep.
3. Wall Plates: Material and finish to match wiring device and wall plate finishes specified in Section 262726, complying with system design standards and UL 514C.
4. Faceplates: High impact thermoplastic, complying with system design standards and UL 514C.
5. Labels: Comply with TIA/EIA-606 using encoded identifiers; label each jack on the face plate as to its function with a unique numerical identifier.

2.7 POWER DISTRIBUTION UNIT (PDU)

A. Equipment Racks and Enclosures:

1. Great Lakes cat# GL7352D

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.

B. Comply with latest editions and addenda of TIA-570, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

3.2 PATHWAYS

A. Install with the following minimum clearances:
   1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
   2. 12 inches from power conduits and cables and panelboards.
   3. 5 inches from fluorescent and high frequency lighting fixtures.
   4. 6 inches from flues, hot water pipes, and steam pipes.

B. Conduit:
   1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
   2. Leave pull cords in place where cables are not initially installed.
   3. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
      a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
      b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
      c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
      d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.

C. Outlet Boxes:
   1. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of telecommunications outlets provided under this section.
      a. Mounting Heights: Unless otherwise indicated, as follows:
         1) Telephone and Data Outlets: 18 inches above finished floor.
         2) Telephone Outlets for Side-Reach Wall-Mounted Telephones: 54 inches above finished floor to top of telephone.
         3) Telephone Outlets for Forward-Reach Wall-Mounted Telephones: 48 inches above finished floor to top of telephone.
      b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
      c. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.

D. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.

E. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 078400.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:
   1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
   2. Do not over-cinch or crush cables.
   3. Do not exceed manufacturer's recommended cable pull tension.
   4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
   1. At Distribution Frames: 120 inches.
   2. At Outlets - Copper: 12 inches.
   3. At Outlets - Optical Fiber: 39 inches.

C. Copper Cabling:
   1. Category 5e/6: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
   2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
   3. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.

D. Fiber Optic Cabling:
   1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
   2. Support vertical cable at intervals as recommended by manufacturer.

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

F. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
   1. Cables: Install color coded labels on both ends.
   2. Outlets: Label each jack on its face plate as to its type and function, with a unique numerical identifier.
   3. Patch Panels: Label each jack as to its type and function, with a unique numerical identifier.
   4. Patch Cords: Label with jack identifier corresponding to initial installation.

3.4 FIELD QUALITY CONTROL

A. Comply with inspection and testing requirements of specified installation standards.

B. Visual Inspection:

1. Inspect cable jackets for certification markings.
2. Inspect cable terminations for color coded labels of proper type.
3. Inspect outlet plates and patch panels for complete labels.
4. Inspect patch cords for complete labels.

3.5 FINAL TESTING AND INSPECTION

A. Provide testing in accordance with ANSI/TIA/EIA-568-C.1.

B. Cable Test: Provide prior to substantial completion, a Performance Evaluation Report, which will contain the following:
   1. Cable Test: List by cable number each UTP Cable in the project, which details:
      a. UTP Cables:
         1) Cable ID Number
         2) List continuity, reversal, open, shorts and miswires
         3) Category performance
         4) List other discrepancies with the UTP installation (bad terminations, faulty labeling, etc).
         5) Tester printout for each cable.
   2. UTP Cable Testing: Test each cable pair of each cable after installation for Specified Category performance. Conduct test with a tester designed for testing above cable (with RJ-45 jacks installed) from each data outlet to associated patch cord through +0 panel jack (Channel). Provide printout for each test as part of the Performance Evaluation Report. Minimum performance categories for report are to be as follows:
      a. Wire Map/Continuity
      b. Length
      c. Near End Crosstalk (pair to pair) NEXT
      d. Near End Crosstalk (power sum) PSNEXT
      e. Equal Level Far-End Crosstalk Loss (pair to pair) ELFEXT
      f. Equal Level Far-End Crosstalk Loss (power sum) PSELFEXT
      g. Return Loss
      h. Attenuation
      i. Propogation Delay
      j. Delay Skew
      k. PSACR (Powersum Attenuation – Crosstalk Ratio)
   3. System Performance Report: Provide a narrative detailing the system as a whole, in regard to the quality of installation and any discrepancies affecting performance. This narrative to indicate a summary of the above Cable Test, as well as an accurate summary of specified Category performance as well as capability of the cabling system to perform at specified Category bandwidth.

1.2 WARRANTY

A. The installation shall be provided with a minimum 25-year **CHANNEL** warranty for strict compliance with the performance requirements of ANSI/TIA/EIA-568-C.1 to support and conform to ANSI/TIA/EIA-568-C.1 specifications covering any current or future

application which supports transmission over a properly constructed horizontal cabling system premises network which meets the channel performance as described in ANSI/TIA/EIA-568-C.2.

END OF SECTION 27 1005

SECTION 275319 - EMERGENCY RESPONDER RADIO COMMUNICATION SYSTEM SECTION I (ERRCS)

PART 1 GENERAL

1.1 SUMMARY

A. Furnish, install, and test a complete and operating Emergency Responder Radio Antenna/Repeater System (ERRCS). The system will support the Fire Department radio system and other first responders. The system is not intended to support cell phone carriers or the Owner's private security and/or maintenance personnel radio systems, now or in the future.

B. This Section includes the requirements for an Emergency Responder Radio Antenna/Repeater System for the purposes of amplifying Emergency Responder radio signals to achieve minimum signal strength in 95% of all areas on each floor of the building. The contractor shall contact the authority having jurisdiction and obtain the current communications frequency.

C. Final acceptance and approval is required from the local Fire Department and other first responders in writing prior to contract closeout.

D. Section Includes
1. Bi-directional amplifiers (BDA's)
2. Antennas
3. Coaxial cables. Plenum rated cable
4. Splitters and direction couplers
5. UPS/ BBU
6. All other equipment and components necessary for a complete and functioning

1.2 REGULATIONS

A. Codes, regulations and standards referenced in the Section are:
1. NFPA 1 -The National Fire Code (including Annex O from 2009)
2. NFPA 70- The National Electrical Code
3. Local State Fire Code Emergency Responder Radio Coverage
4. NFPA 101, Life Safety Code, the Ohio Basic Building Code, and Local Code and Building Authority requirements.
5. NFPA 72-07 National Fire Alarm Code
6. FCC 47 CFR Private Land Mobile Radio
7. 90.219-2007 Services-Use of Signal Boosters
8. ICC 2009 International Fire Code, Code and Commentary
10. ADA "Americans with Disabilities Act"
11. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency
Electromagnetic Fields".

12. FCC Rules Part 22, Part 90 and Part 101.
13. I F C International Fire Code, Section 510.
14. System shall comply with UL2524 classified with respect to electrical shock and fire.

1.3 DEFINITIONS

A. Definitions:

1. Bi-Directional Amplifier BDA: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station for enhanced signals and improved coverage.

2. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
3. Delivered Audio Quality Definitions (DAQ): This is a universal standard often cited in system designs and specifications.
   a. DAQ 1: Unusable, speech present but unreadable.
   b. DAQ 2: Understandable with considerable effort. Frequent repetition due to noise/distortion.
   c. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise/distortion.
   d. DAQ 3.5: Speech understandable with repetition only rarely required. Some noise/distortion
   e. DAQ 4: Speech easily understood. Occasional noise/distortion.
   f. DAQ 4.5: Speech easily understood. Infrequent noise/distortion.
   g. DAQ 5: Speech easily understood. Coupled Bonding Conductor (CBC)- The term "Coupled Bonding Conductor" shall mean a bonding conductor placed, e.g. strapped, on the outside of any technology cable, used to suppress transient noise.
4. FCC: Federal Communications Commission
5. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
6. Public Safety/First Responder: Public Safety or First Responder agencies which are charged with the responsibility of responding to emergency situations. These include, but are not limited to: law enforcement departments, fire departments, and emergency medical companies.

1.4 SUBMITTALS

A. Submit product data for each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features.

B. Layout Drawings

1. Component specification sheets shall be 8.5 inch x 11 inch or greater, scaled or dimensioned, with dimensions or scale clearly noted.
2. Floor plan drawings shall be 24 inch x 36 inch minimum with drawings scaled to legible size.
3. Floor plan drawings may include elevation detail names for each elevation view. Sheet title shall include site name, address, sheet number, floor plan number and north arrow. Include site plan view of the subject buildings and surrounding property to clearly indicate the location and orientation of roof mounted outdoor antennas associated with the proposed system.
4. Include a minimum of (1) building elevation depicting the location of any outdoor antennas associated with the proposed system. Include height of antenna centerline above building, orientation, and location of all external grounding connections.
5. Include a detail plan view of all Telecommunications Spaces housing head-end and/or other consolidated equipment, showing the location of the rack(s) and/or enclosure(s) of the Emergency Responder Radio Antenna/Repeater System equipment.
6. Include a separate plan view of each interior floor where indoor antenna systems are proposed. Include antenna numbers, coaxial cable routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. All components shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating -95 dBm downlink (base to mobile) signal strength around each proposed indoor coverage antenna. Include results of any previous coverage testing per grid, if available.
7. Include a minimum of one (1) detail elevation view(s) of all rack(s) and/or enclosure(s) housing the Emergency Responder Radio Antenna/Repeater System equipment. Identify each piece of equipment by brand, model number and equipment type (e.g. Acme BA123 RF amplifier).
8. Specify antenna grounding and surge protection in accordance with NEC Article 810.
9. Specify the backup power source (Life Safety), and include calculations to ensure the backup power requirements as specified in this standard are met.

C. Equipment Specification Sheets

1. Provide copies of manufacturer specification sheets of all system components, including:
   a. Repeaters
   b. Antennas

c. Coaxial cable, couplers, splitters, combiners, or other passive components

2. Operation and maintenance data.
4. Backup battery and charging system.

D. Submit wiring diagrams from manufacturer differentiating clearly between factory and field- installed wiring. Include diagrams for each component of the system with all terminals and interconnections identified. Make all diagrams specific to this Project.

E. Submit product certificates signed by the manufacturer of radio system components certifying that their products comply with specified requirements.

F. Submit agenda for training class and copies of all handouts for the class.

G. Maintenance data for radio system shall be included in the operation and maintenance manual. Include data for each type of product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

H. Record of field tests of the radio system shall be included in the operation and maintenance manuals.

I. Design Approval: Plans shall be submitted and approved prior to installation. The following information shall be provided to the local Fire Department unit representative by the system designer/Contractor:

1. A minimum of three (3) copies of detailed drawings showing the location of the amplification equipment and associated antenna systems which includes a view showing building access to the equipment; and
2. A minimum of three (3) copies of schematic drawings of the electrical system, backup power, antenna system and any other associated equipment relative to the amplification equipment including panel locations and labeling.
3. A minimum of one (1) copy of the Manufacturer's data sheets on all equipment to be installed.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced factory-authorized installer to perform work of this Section.

B. Single-Source Responsibility: Obtain radio system components from a single source who assumes responsibility for compatibility of system components.

C. All equipment shall be UL listed and labeled, and in accordance with applicable NEMA and ANSI Standards. Where copper cabling is routed to an area, either in another building, or with a separate electrical service, the Technology Contractor shall provide primary protective equipment.

D. All racks and enclosures shall be either welded or assembled with paint piercing ground washers, grounding strip and bonding jumper as indicated on the Drawings.

1.6 MANUFACTURERS

A. Subject to compliance with requirements, the ERRCS must be designed utilizing products from the following OEMs, alternate can be offer by providing all technical specifications that meet and exceed the RF and state code requirements.

1. Advanced RF Technologies- ADRF
2. Similar or equal that are NFPA/ IFC Complaint. (provide spec sheets and describe reason for substitution) and UL 2524 Certified

PART 2 PRODUCTS

2.1 GENERAL PERFORMANCE REQUIREMENTS

A. Compatibility: The equipment, including but not limited to repeaters, transmitters, receivers, signal boosters, cabling, fiber distributed antenna system, etc., shall not interfere with the existing communication systems utilized by the Public Safety and First Responder agencies.

B. Power Supplies: At least two (2) independent and reliable power supplies shall be provided, one primary and one secondary. The primary power source shall be supplied from a dedicated 20 ampere branch circuit and comply with 4.4.1.4 of NFPA 72. The secondary power source shall be a dedicated battery, capable of operating the in-building radio system for at least 12 hours of 100% system operation, The battery system shall automatically charge in the presence of external power input The battery system shall be contained in one NEMA 4 or 4X type enclosures, Monitoring the integrity of power supplies shall be in accordance with 4,4,7,3 of NFPA 72 or local AHJ requirement.

C Survivability

L Physical Protection: All wiring and fiber optics shall be installed in conduit or as required by the local AHJ

2, Fire Performance: All main risers or trunks of the antenna system shall be installed with resistance to attack from a fire using one of the following methods:
   a, A 2-hour fire rated vertical shaft wall or cable system riser,
   b, Routing the cable through a 2-hour fire rated enclosure(s) or shaft(s),
   c, Performance alternative approved by the authority having jurisdiction,
3, Cabinet: The signal booster and all associated RF filters shall be housed in a single, NEMA 4 certified, painted steel weather tight box, The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere, Operating temperatures: -22 degrees F to+120 degrees F (-30 degrees C to +50 degrees C) minimum temperature range, including microprocessors, Equipment installed on the roof of structures shall be rated for the expected extreme temperatures associated with rooftop installations,
4, Passive Equipment: Passband shall be 700-900 MHz,
5, Cable: Passband shall be 700-900 MHz, Cable shall be rated for fire plenum and riser rating,

D Annunciator Panel

A dedicated monitoring panel shall be provided within the emergency command center or other location as designated by AHJ to annunciate the status of repeater status. The annunciator panel shall provide visual and labeled indication of the following status:

a. Normal AC power
b. Loss of normal AC Power
c. Battery Charger Failure
d. Low Battery Capacity (70% depletion)
e. Donor Antenna Malfuncition
f. Active RF Emitting Device Malfunction
g. System Component Malfunction
h. Donor Antenna Disconnection

2.2 SYSTEM COMPONENTS

A Signal Strength

L Downlink: A minimum signal strength of -95 dBm shall be provided throughout the
Coverage area.

2, Uplink: Minimum signal strength of -95 dBm received at the local Fire Department
Radio System from the coverage area,

3, A donor antenna must maintain isolation from the distributed antenna system, The donor antenna signal isolation level shall be a minimum of 15 dB above the distributed antenna system gain under all operating conditions,

B Permissible Systems

L Buildings and structures shall be equipped with an FCC Certificated Class A or Class B Bi-Directional Amplifier(s) as needed/ required by AHJ.

C Supported Frequencies: The radio system shall support frequencies in the 700 and 800 MHz public safety bands as utilized by the local Fire Department (VHF or UHF as required by AHJ)

D, Output Level Control: An automatic output leveling circuit shall be included for both passbands with a minimum dynamic range of 60 dB, less any gain reduction setting, to maintain FCC out of band and spurious emission compliance.

E. Mode of Operation: The system shall be normally powered on and shall continuously provide passing of frequencies within the Public Safety and First Responder bands.

F. All in-building radio systems shall be compatible with both analog and digital communications simultaneously at the time of installation.

2.3 SYSTEM MONITORING

A. The distributed antenna system shall include a connection to the fire alarm system to monitor the integrity of the circuit of the signal booster(s) and power supplies and annunciate this malfunction on the fire alarm system shall comply with 4.4.7.1 of NFPA 72.

B. A sign shall be located at the fire alarm panel with the name and telephone number of the local Fire Department indicating that they shall be notified of any failures that extend past the 2 hour time limit.

PART 3 EXECUTION

3.1 INSTALLATION

A. Distribution System Signal Wires and Cables

1. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.
2. Routing and Interconnection
   a. Wires or cables routed between consoles, cabinets, racks, and other equipment shall be installed in an approved conduit or cable tray that is secured to building structure.
   b. Completely test all of the cables after installation and replace any that are found to be defective.

3. Install cables without damaging conductors, shield, or jacket.
4. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
5. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

B. Product Delivery, Storage, and Handling
1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment model and serial identification numbers.
2. Store and protect equipment in a conditioned space until installation.

C. System Installation
1. Coaxial antenna cabling shall not be installed in the same conduit, raceway, or cable trays used for other systems.
2. All equipment shall be connected according to the OEM's specifications to insure correct installation and system performance.
3. Coordinate all roof penetrations with Owner and/or roofing contractor.

3.2 LICENSING

A. All fees associated with the licensing shall be paid by

the Owner. B. All testing must be done on frequencies

authorized by the FCC.

3.3 GROUNDING

A. Ground cable shields and equipment per Manufacturer's requirements.

B. Antenna mast shall be grounded per NFPA 70 NEC requirements, Section 27 05 26, "Grounding and Bonding for Communications Systems" and antenna manufacturer's requirements. Provide grounding blocks and surge protection for outside coaxial cabling. Bond the antenna mast to the existing lightning protection system.

3.4 APPROVAL TESTING

A. The local Fire Department will review plans and specifications. Upon acceptance, plans will be stamped to indicate approval. Stamped plans are required to be present at the acceptance test. Any field changes that occur during construction shall be incorporated into new As- Built plans, including any manufacturer's data sheets for any equipment changes not submitted in the original submittal. As-Built plans, if required due to system changes, shall be submitted to the local Fire Department for approval.

B. Tests shall be made using frequencies close to the frequencies used by the Fire Department and appropriate emergency services. If testing is done on the actual frequencies, then this testing must be coordinated with the local Fire Department unit. All testing must be done on frequencies authorized by the FCC.

C. Testing Procedures
1. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.0 shall be considered a failed test for a given grid cell.
2. Measurements shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.

D. Final Acceptance Testing
1. All acceptance testing shall be done in the presence of a local Fire Department representative or by the local Fire Department unit at no expense to the City.
2. Small scale drawings (11 inch x 17 inch maximum) of the structure shall be provided by the Contractor to the Owner. The plans shall show each floor divided into the grids as described above, and the results of the pre-testing. Each grid shall be labeled to indicate the DAQ result from the final acceptance testing.
3. The Contractor shall provide the latest approved plans for the system, including any manufacture's data sheets for any equipment changes not submitted in the original submittal to the Owner.
4. Include testing results of the repeater (output wattage, gain level, etc.) and connection to the fire alarm.

3.5 MAINTENANCE AND ANNUAL TESTING **(OPTIONAL/ as required by AHJ)**

A. Annual tests will be conducted by the local Fire Department unit or authorized company.
1. The re-testing will be done at no expense to the City or the appropriate emergency services departments as required in the original testing procedures.

B. Maintenance Contract
1. Maintenance contract with a Radio Service Provider in place with name of authorized company, who will provide a 24 hour by 7 day emergency response within two (2) hours after notification. The system shall be maintained in accordance with FCC requirements. The contract shall be for 5 years.
2. All tests shall be conducted, documented, and signed by a technician certification issued by BDA Manufacturer or equivalent as determined by the local Fire Department.

3. Maintain a list of contact personnel with phone numbers at the radio repeater system cabinet. The contact personnel shall have knowledge of the building and the repeater system and be available to respond to the building in the case of an emergency.
4. Radio Service Provider maintenance contract shall include but not limited to:
   a. Annual Test
      I) All active components of the distributed antenna system, including but not limited to amplifier, power supplies, and back-up batteries, shall be tested a minimum of once every 12 months.
      2) Amplifiers shall be tested to insure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
      3) Back-up batteries and power supplies shall be tested under load for a period of I hour to verify that they will operate during an actual power outage.
      4) Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
      5) Documentation of the test shall be maintained on site and a copy forwarded to the local Fire Department Radio Supervisor upon completion of the test.
5. Fire Department Radio personnel, after providing reasonable notice to the Owner or their representative, shall have the right to enter onto the property to conduct field testing to be certain that the required level of radio coverage is present

END OF SECTION 275319

SECTION 28 4600 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fire alarm system design and installation, including all components, wiring, and conduit.

B. Transmitters for communication with supervising station.

C. Circuits from protected premises to supervising station, including conduit.

D. Maintenance of fire alarm system under contract for specified warranty period.

1.2 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping: Materials and methods for work to be performed by this installer.

B. Section 08 3323 - Overhead Coiling Doors: Coiling fire doors to be released by fire alarm system.

C. Section 08 7100 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.

D. Section 14 2100 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.

E. Section 14 2400 - Hydraulic Elevators: Elevator systems monitored and controlled by fire alarm system.

F. Section 21 1300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.

G. Section 21 3000 - Fire Pumps: Supervisory devices.

H. Section 23 3300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

I. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems: Requirements for the seismic qualification of equipment specified in this section.

1.3 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.

C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).

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

E. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

F. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems; Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

B. Proposal Documents: Submit the following with cost/time proposal:

1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
3. Certification by Contractor that the system design will comply with Contract Documents.
4. Proposed maintenance contract.

C. Evidence of designer qualifications.

D. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:

1. Copy (if any) of list of data required by authority having jurisdiction.
2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
4. System zone boundaries and interfaces to fire safety systems.
5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
7. List of all devices on each signaling line circuit, with spare capacity indicated.
8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.

9. Air-Sampling Smoke Detection Systems: Include air-sampling pipe network layout with sampling ports identified; include calculations demonstrating compliance with specified requirements.
10. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
12. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
13. Certification by Contractor that the system design complies with Contract Documents.

E. Manufacturer's equipment seismic qualification certification.

F. Evidence of installer qualifications.

G. Evidence of instructor qualifications; training lesson plan outline.

H. Evidence of maintenance contractor qualifications, if different from installer.

I. Inspection and Test Reports:

1. Submit inspection and test plan prior to closeout demonstration.
2. Submit documentation of satisfactory inspections and tests.
3. Submit NFPA 72 "Inspection and Test Form," filled out.

J. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:

1. Complete set of specified design documents, as approved by authority having jurisdiction.
2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
4. List of recommended spare parts, tools, and instruments for testing.
5. Replacement parts list with current prices, and source of supply.
6. Detailed troubleshooting guide and large scale input/output matrix.
7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

K. Project Record Documents: See Section 01 7800 for additional requirements; have one set available during closeout demonstration:

1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

L. Closeout Documents:

1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
3. Certificate of Occupancy.
4. Maintenance contract.
5. Report on training results.

M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.

1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
2. Furnish the following:
   a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
   b. One copy, on CD-ROM, of all software not resident in read-only-memory.
   c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.5 QUALITY ASSURANCE

A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.

1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.

2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
4. Certified in the State in which the Project is located as fire alarm installer.

C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 WARRANTY

A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fire Alarm Control Units and Accessories - Basis of Design: Silent Knight.

B. Fire Alarm Control Units and Accessories - Other Acceptable Manufacturers:

1. Honeywell Security & Fire Solutions/Gamewell-FCI
2. Honeywell Security & Fire Solutions/Vista
3. Edwards
4. Notifier.
5. Siemens
6. Provide control units made by the same manufacturer.

C. Initiating Devices and Notification Appliances:

1. Same manufacturer as control units.

D. Substitutions: See Section 01 6000 - Product Requirements.

1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.

2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.2 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:

1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
   a. ADA Standards.
   b. The requirements of the local authority having jurisdiction.
   c. Applicable local codes.
   d. Contract Documents (drawings and specifications).
   e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
7. Program notification zones and voice messages as directed by Owner.
8. Fire Alarm Control Unit: New, located at location indicated on drawings.
9. Combined Systems: Do not combine fire alarm system with other non-fire systems.

B. Supervising Stations and Fire Department Connections:

1. Public Fire Department Notification: By on-premises supervising station.
2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at _____.
3. Remote Supervising Station: UL-listed central station under contract to facility.
4. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), One telephone line and Internet connection..

C. Circuits:

1. Initiating Device Circuits (IDC): Class B, Style A.
2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
3. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Speaker Amplifiers: Minimum 25 percent spare capacity.
4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:

1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
4. Each Computer System: Provide uninterruptible power supply (UPS).

F. Seismic Qualification: Provide fire alarm system and associated components suitable for application under the seismic design criteria specified in Section 26 0548 where required. Include certification of compliance with submittals.

2.3 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:

1. Sprinkler water control valves.
2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.
4. Fire pump(s).
5. Elevator shut-down control circuits.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:

1. Sprinkler water flow.
2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
4. Duct smoke detectors.

C. Elevators:

1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:

1. Duct Smoke Detectors: Close dampers indicated; shut down air handler associated Air-Handling Unit. Notify BAS System of specific Air-Handling Unit shutdown.

E. Doors:

1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 7100.
2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 7100.
3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 3323.

2.4 COMPONENTS

A. General:

1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Control Unit: As specified for Basis of Design above, or equivalent.

D. Remote Annunciators: Locate (1) in each Main Lobby (Total 2-annunciators).

E. Initiating Devices:

1. Addressable Systems:
   a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
   b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
2. Manual Pull Stations.
3. Smoke Detectors.
4. Duct Smoke Detectors.
5. Heat Detectors.

6. Addressable Interface Devices: Provide Addressable interface devices required for monitoring dry contacts (Flow & Tamper Switches, Knox Box, etc.) and control relays to initiate action (Air-handling unit shutdown, Door release, Kitchen Shunt-trip for power units below hood, ect.) .

F. Notification Appliances:

1. Speakers.
2. Strobes.

G. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

H. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.

I. Locks and Keys: Deliver keys to Owner.

1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type

J. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.

1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.

B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Obtain Owner's approval of locations of devices, before installation.

D. Install instruction cards and labels.

E. Perform system voice intelligibility testing for large spaces with sound reflective surfaces including but not limited to Gymnasiums, Cafeteria, LGI classrooms. Test in accordance to national guidelines, and provide system modifications (addition of speakers, adjustment of speaker taps, etc.) as required unitl results are within acceptable levels.

3.2 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.

B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.

D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.

E. Provide all tools, software, and supplies required to accomplish inspection and testing.

F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.

G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.

1. Record all system operations and malfunctions.
2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.3 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:

1. Hands-On Instruction: On-site, using operational system.
2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
3. Factory Instruction: At control unit manufacturer's training facility.

B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:

1. Initial Training: 1 session pre-closeout.

C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:

1. Initial Training: 1 session pre-closeout.

D. Detailed Operation: Two-hour sessions for engineering staff; assume NICET level I qualifications or equivalent; combination of classroom and hands-on:

1. Initial Training: 1 session pre-closeout.

E. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:

1. Initial Training: One 3-day session, pre-closeout.
2. Refresher Training: One 1-day session post-occupancy.

F. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

G. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

3.4 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.

1. Be prepared to conduct any of the required tests.
2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.

B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:

1. Specified diagnostic period without malfunction has been completed.
2. Approved operating and maintenance data has been delivered.
3. Spare parts, extra materials, and tools have been delivered.
4. All aspects of operation have been demonstrated to Owner.

5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
6. Occupancy permit has been granted.
7. Specified pre-closeout instruction is complete.

C. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.5 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:

1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:

1. Provide on-site response within 2 hours of notification.
2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

END OF SECTION 284600

SECTION 285500 - RF SURVEY FOR EMERGENCY RESPONDER RADIO ANTENNA/ REPEATER BDA SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. The purpose of this specification is to establish the requirements and standards for initial survey for public safety radio signal strength per NFPA and IFC

B. Survey should be performed after the building is substantially completed, and prior to start of installation of electrical wiring.

C. Conduct a survey using a RF Spectrum Analyzer, a calibrated, system-compatible radio or another suitable instrument with traceable certificate of calibration to analyze the RF signal strength of Emergency Responder Radio Signal into the building and determine if amplification of the signal is required. Both inbound and outbound signal strength shall be determined, measured, calculated and documented as required by code.

1.2 SURVEY CRITERIA IF REQUIRED

A. The required Public Safety Radio Signal Level inside the Owner's facility must be determined per code, ordinance or AHJ

B. Survey shall be performed by an FCC licensed technician holding a current GROL license. NOTIFIER have distributors that meet these requirements.

1.3 REGULATIONS

A. Codes, regulations and standards referenced in the Section are:

1. NFPA 1 – The National Fire Code (including Annex O from 2009)
2. NFPA 70 – The National Electrical Code
3. IFC 510- Emergency Responder Radio Coverage
4. NFPA 101, Life Safety Code, the Ohio Building Code, and Local Code and Building Authority requirements.
5. NFPA 72 National Fire Alarm Code
6. FCC 47 CFR Private Land Mobile Radio
7. 90.219 Services-Use of Signal Boosters
8. ICC International Fire Code, Code and Commentary
9. Local or State Promulgated Fire Code
10. ADA "Americans with Disabilities Act"
11. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields"
12. FCC Rules Part 22, Part 90 and Part 101
13. NFPA 1221 2016 Edition

14. International Building Code 2012 / 2015 / 2018
15. UL 2524

1.4 DEFINITIONS

A. Definitions:

1. Bi-Directional Amplifier BDA: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station and in the downlink from the base station to subscriber devices for enhanced signals and improved coverage.
2. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services, or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
3. FCC: Federal Communications Commission
4. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
5. Public Safety/First Responder: Public Safety or First Responder agencies that are charged with the responsibility of responding to emergency situations. These include, but are not limited to law enforcement departments, fire departments, and emergency medical companies.
6. RSSI: Received signal strength indicator RSSI is a measurement of the power present in a received radio signal.
7. BER: Bit Error Rate is the number of bit errors per unit time
8. GROL- FCC General Radio Operators License
9. ERRCES- Emergency Responder Radio Coverage Enhancement System
10. DAS-Distributed Antenna System

1.5 EXECUTION

A. Testing Procedures

1. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the. -95dBm nominal signal at 100%.
2. Spectrum Analyzer or Calibrated Handheld Radio shall be used as basis for signal measurements or other method as approved by AHJ.
3. Testing should be based on a minimum of 20 grid locations per floor OR maximum of 1600 SQ ft. areas if the floor exceeds 32,000 Sq. Ft. Also, testing should include all critical areas per NFPA. See 1.02 of this specification and NFPA 72 2013 or NFPA 1221 2016. OR per any method determined by the AHJ, local code or ordinance.
3. A minimum signal strength of -95 dBm shall be provided throughout the coverage area for both uplink and downlink by the Local Fire Department.
   a. RSSI measurement only

1.6 SURVEY SUBMITTALS

A. Submit testing data for each level of the building.

1. An RF measurement drawing of each floor of the building which indicates relative RF field strength for each frequency band of interest must be submitted to the AHJ.
2. The drawing should indicate clearly the areas that have passed or failed based on the above parameters.

END OF SECTION 28 5500

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SECTION 312316.13 - TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 RELATED REQUIREMENTS

A. Section 312200 - Grading: Site grading.

B. Section 312316 - Excavation: Building and foundation excavating.

C. Section 312316.26 - Rock Removal: Removal of rock during excavating.

D. Section 312323 - Fill: Backfilling at building and foundations.

E. Section 334600 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.

1.3 DEFINITIONS

1.4 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010.

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

1.5 SUBMITTALS

A. 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.

END OF SECTION 312316.13

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 013000 - 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 at ____ feet on center.

O. Cable Rack Mounting Channel: 1-1/2 x 3/4 inch steel channel, 48 inch length. Provide cable rack arm mounting slots on 1-1/2 inch centers.

P. Cable Racks: Steel channel, 1-1/2 x 3/4 x 14 inches, with fastener to match mounting channel.

Q. Cable Supports: Porcelain clamps and saddles.

R. Manhole Steps: Polypropylene plastic manhole step with 1/2-inch steel reinforcement.

S. Source Quality Control: Inspect manholes in accordance with ASTM C1037.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

C. Verify locations of manholes prior to excavating for installation.

D. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.

E. Manhole locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.

3.2 DUCT BANK INSTALLATION

A. Install duct to locate top of ductbank at depths as indicated on drawings.

B. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.

C. Cut duct square using saw or pipe cutter; de-burr cut ends.

D. Insert duct to shoulder of fittings; fasten securely.

E. Install no more than equivalent of three 90-degree bends between pull points.

F. Provide suitable fittings to accommodate expansion and deflection where required.

G. Stagger duct joints vertically in concrete encasement 6 inches minimum.

H. Use suitable separators and chairs installed not greater than 4 feet on centers.

I. Band ducts together before backfilling.

J. Securely anchor duct to prevent movement during concrete placement.

K. Place concrete under provisions of Section 033000. Use mineral pigment to color concrete red.

L. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.

M. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.

N. Provide suitable pull string in each empty duct except sleeves and nipples.

O. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

P. Interface installation of underground warning tape with backfilling. Install tape 12 inches below finished surface.

3.3 PRE-CAST MANHOLE INSTALLATION

A. Excavate for manhole installation under the provisions of Section 312316.

B. Install and seal precast sections in accordance with ASTM C891.

C. Install manholes plumb.

D. Use precast neck and shaft sections to bring manhole cover to finished elevation.

E. Attach cable racks to inserts after manhole installation is complete.

F. Backfill manhole excavation under the provisions of Section 312323.

END OF SECTION 337119

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