SPECIFICATIONS

PROPOSED RENOVATION & ADDITION
FOR
COLUMBIA COUNTY JUSTICE CENTER
640 RONALD REAGAN DRIVE
EVANS, GEORGIA 30809

BOOKER+VICK ARCHITECTS

670 Broad Street
Augusta, Georgia 30901

BOARD OF COMMISSIONERS

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CIVIL ENGINEER:	BLUEWATER ENGINEERING BILL CORDER, PE	FIRE PROTECTION ENGINEER:	PFA ENGINEERING, INC. JOE C. POWELL, PE
STRUCTURAL ENGINEER:	SLATER ENGINEERING BRIAN SLATER, PE	ELECTRICAL ENGINERR:	ELECTRICAL DESIGN CONSULTANTS TOM BRINSON, PE
MECHANICAL ENGINEER:	PFA ENGINEERING, INC. BRIAN MESSER, PE	INTERIOR DESIGNER:	CORPORATE STUDIO LISA BURGESS, RID
PLUMBING ENGINEER:	PFA ENGINEERING, INC. JOE C. POWELL. PE		

Volume II of II

ISSUED FOR BID - JANUARY 29, 2024

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Division	Section Title	Pages

VOLUME I

DIVISION 04 - MASONRY

DIVISION 05 - METALS

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

VOLUME II

DIVISION 23 - HVAC

DIVISION 26 – ELECTRICAL

SECTION 210000

GENERAL FIRE SUPPRESSION PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes general provisions covering the contract documents for Fire Protection Systems.

1.3 DEFINITIONS

A. Provide shall mean "Furnish, install and connect."

B. Piping shall mean "pipe installed with all specified fittings, valves and accessories, and forming a complete system."

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Electrical Coordination: In addition to submittal requirements of other Division 21 Sections, submit a document approved by the project Electrical Contractor certifying that all fire sprinkler equipment being furnished under Division 21 complies with the electrical characteristics of the source power which will be furnished under Division 26.

C. Model numbers listed on the Fire sprinkler Contract Documents shall not be construed to indicate electrical characteristics. Electrical characteristics of fire sprinkler equipment shall be as indicated on the Electrical Contract Documents (Division 26).

D. Review of Submittals does not relieve the Contractor of any of the requirements of the Contract Documents. Failure by the Engineer to document errors and omissions in the Contractor's submittals during the Engineer's submittal review does not constitute a waiver of any of the requirements of the original Contract Documents.

1.5 CONTRACTOR QUALIFICATIONS

A. Fire Protection System Installer qualifications shall be specified in other sections of Division 21.

1.6 PRIOR APPROVALS

A. Manufacturers References: When reference is made in the Contract Documents to trade names or specific manufacturers and/or models, such reference, unless noted otherwise, is made to designate and identify the quality of materials or equipment to be furnished and is not intended to restrict competitive bidding. If it is desired to use materials or equipment different from those indicated on the Contract Documents, written request for approval must reach the hands of the Design Professional at least TEN DAYS prior to the date set for the opening of bids. A copy of the request should also be sent directly to the Engineer. Requests for prior approval of a proposed substitute shall be accompanied by complete technical data supporting the request.

B. Request for Prior Approval by facsimile transmission (fax) or email will not be considered. Prior approval requests shall be submitted in hard copy format only.

1.7 LAYOUT AND COORDINATION

A. Layout Basis:

1. The equipment listed on the Drawings and in the Specifications has been used for the physical arrangement of the fire sprinkler systems. When equipment listed as acceptable, equal or equipment which has received "prior approval" is used, it shall be the Contractor's responsibility to provide structural, electrical, service clearances, or other changes required to accommodate the substituted equipment. Changes shall be made at no additional cost to the Owner. Submit a list of required changes along with all prior approval requests and shop drawing submittals.
2. The Contract Drawings are intended to show the general arrangement of all fire sprinkler work. They do not show in detail all offsets, fittings and transitions. Examine Drawings, investigate site conditions to be encountered and arrange work accordingly. Furnish all offsets and transitions required.
3. Drawings do not indicate in detail exact configuration of connections for fixtures, equipment and accessories. Final connection shall be as shown on approved Manufacturer's Submittal Drawings. Where Manufacturer's Submittal Drawings conflict with the Contract Documents, confer with the Design Professional for resolution.
4. Measurement of Drawings by scale shall not be used as dimensions for fabrication. Measurements for locating fixtures, equipment, ductwork, piping and other fire sprinkler items shall be made on the site and shall be based on actual job conditions.
5. Check space limitations and verify electrical requirements before ordering any fire sprinkler equipment or materials. Place large equipment inside the building prior to the erection of exterior walls where equipment cannot enter finished building openings.

B. Coordination: Fire sprinkler work shall be coordinated with that of other trades to avoid conflict. The Contractor shall study all plans and specifications for this project and shall notify the Design Professional of any conflict between work under Division 21 and work under other divisions of the Project. Particular attention shall be given to interference between piping, electrical installations, structural systems, building openings and ductwork.

C. Installation Instructions: Two binders containing manufacturer's installation instructions for all equipment furnished under Division 21 shall be furnished by the Contractor. One binder shall be kept in the General Contractor's office at the job site. The other binder shall be delivered to the Engineer upon acceptance by the Design Professional of the Submittals.

D. Operation and Maintenance Instructions: Three copies of equipment O&M manuals contained in rigid 3-ring binders shall be submitted to the Owner a minimum of 15 days prior to equipment/systems training. Binders shall have permanent labels on the spine and front cover indicating project name, project number, building name and contents. Model and serial numbers of equipment shall be shown on the cover of their respective O&M manual(s).

1.8 PERMITS

A. Obtain all necessary Permits and Inspections required for the installation of this work and pay all charges incident thereto. Deliver to the Design Professional all certificates of inspection issued by authorities having jurisdiction.

B. Fire marshal submittal fees, water tap fees, meter fees, and all other charges for work under Division 21, including charges for meter installation and excess service by the utilities shall be paid by the Contractor.

1.9 SAFETY

A. OSHA Requirements applicable to the project shall be complied with at all times.

B. Manufacturer's Safety Instructions shall be followed in all instances.

C. Asbestos Containing Materials (ACM) shall not be used on this project.

D. Electrical Equipment Clearances: Piping, equipment and other fire sprinkler installations shall not be located within 42" of the front or 36" of the side of any electrical switchboards, panelboards, power panels, motor control centers, electrical transformers or similar electrical equipment. Piping shall not pass through or above electrical equipment rooms except as required to serve those rooms.

E. Guards shall be provided where equipment, or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof or grade below. The guard shall extend not less than 30 inches beyond each end of such equipment, components and roof hatch openings and the top of the guard shall be located not less than 42 inches above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21 inch diameter sphere and shall comply with the loading requirements for guards specified in the International Building Code.

1.10 PROTECTION OF FIRE SUPPRESSION SYSTEMS DURING CONSTRUCTION

A. Material storage:

1. All materials and equipment stored on the jobsite shall be elevated above the ground and stored under suitable weather cover. Materials and equipment shall not be situated in areas subjected to localized flooding.
2. Manufacturer’s original shipping packaging and protective coverings shall be left in place until the equipment is prepared for installation.

B. Electrical enclosure protection:

1. During construction, all protective covers and other devices shall be left in place that protect against inadvertent contact with live electrical circuits.
2. All warning labels related to electrical and rotating equipment hazards shall be in place prior to energizing fire sprinkler equipment circuits.

C. Protection of Equipment and piping:

1. Maintain temporary closures on the ends of all equipment and pipes as the installation work progresses. Temporary closures include plastic sheeting, tape and appropriate caps and covers.
2. Where debris enters piping during installation, steps shall be taken to clean the interior of the pipe prior to placing in service.
3. Where debris enters equipment during installation the equipment interior shall be cleaned prior to placing in service.

1.11 CODES AND STANDARDS

A. Fire sprinkler installations shall conform to the current edition (recognized by the State) of the following, in addition to any previously mentioned Codes and Standards.

1. The International Building Code.
2. The International Fire sprinkler Code.
3. The International Plumbing Code.
4. The International Fire Protection Code.
5. NFPA Standard 13, Installation of Sprinkler Systems.
6. NFPA Standard 70, National Electric Code.

7. NFPA Standard 101, Code for Safety to Life for Fire in Buildings and Structures.
8. NFPA 24 Standard for the installation of private fire service mains and their appurtenances.

1.12 ASBESTOS MATERIALS

A. Contractor is advised there may be **ASBESTOS PRODUCTS** in building(s) which will affect work under this Project. Particular reference is made to piping, equipment and other items that may be modified or removed. It shall be the sole responsibility of Contractor to check for and ascertain presence of asbestos materials where such presence affects work under this Project. Where Contractor ascertains presence of asbestos materials, he shall notify Owner and Engineer in writing of presence of asbestos **BEFORE** beginning any work. Removal of asbestos products shall be the responsibility of Owner **AFTER** he has been notified by Contractor of its presence.

B. Engineer assumes no responsibility of investigating for presence of **ASBESTOS PRODUCTS** or for verifying presence of asbestos materials, nor does Engineer assume any responsibility for specifying, advising on, or supervising removal of any asbestos products. Contractor and Owner shall hold harmless Engineer in any matters involving presence of, or removal of, asbestos products.

1.13 INTERRUPTION OF EXISTING SERVICES

A. Exercise care so as not to cut any existing utilities or services. Where an existing utility line or service line is cut it shall be repaired to "like-new" condition. Interruption of service shall not be made without prior written permission of the Owner.

B. Fire suppression system must remain in service during construction. Arrange with the Owner well in advance of shutdowns required for tie-ins. Shutdowns shall be made after normal occupancy hours if so directed by the Owner. No additional monies will be paid for after-hours shutdowns.

PART 2 - PRODUCTS Not required for this section.

PART 3 - EXECUTION Not required for this section.

END OF SECTION 210000

SECTION 210500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 21 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Field-fabricated metal equipment supports.
3. Installation requirements common to equipment specification Sections.
4. Mechanical demolition associated with the fire sprinkler systems.
5. Cutting and patching.
6. Touchup painting and finishing.

B. Pipe and pipe fitting materials are specified in piping system Sections.

1.3 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Shop drawings detailing fabrication and installation for metal supports and anchorage for mechanical materials and equipment.

C. Coordination drawings for access panel and door locations.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code--Steel."

B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

C. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

D. Coordinate all electrical service requirements for mechanical equipment prior to the submittal of shop drawings. Confirm the compatibility of all power services with the equipment being furnished. Confirm compatibility of electrical lugs being provided by the equipment manufacturer with the power wiring being furnished under Division 26. Furnish written documentation that all characteristics have been coordinated with and confirmed by the electrical subcontractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 21 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch minimum thickness, except where thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face, 1/8-inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

G. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47, Grade 32510 or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.3 PIPING SPECIALTIES

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube, and insulation.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.
   a. Finish: Rough brass.
   b. Finish: Polished chrome plate.

4. Cast Brass: Split casting, with concealed hinge and set-screw.
   a. Finish: Rough brass.
   b. Finish: Polished chrome plate.
5. Stamped Steel: One-piece, with set-screw and chrome-plated finish.
6. Stamped Steel: One-piece, with spring clips and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.
8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
9. Stamped Steel: Split plate, with exposed-rivet hinge, set-screw, and chrome-plated finish.
10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
11. Cast-Iron Floor Plate: One-piece casting.

B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly for 250-psig minimum working pressure at a 180 deg F temperature.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.
6. Dielectric Couplings: Galvanized-steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F temperature.
7. Dielectric Nipples: Electroplated steel nipple, having inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225 deg F temperature.

C. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast-Iron: Cast or fabricated wall pipe equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.
4. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.
   a. Penetrating Pipe Deflection: 5 percent without leakage.
   b. Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.
   c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
   d. Housing-to-Sleeve Gasket: Rubber or neoprene push-on type of manufacturer's design.

5. Cast-Iron Sleeve Fittings: Commercially made sleeve having an integral clamping flange, with clamping ring, bolts, and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

2.4 FIRE-STOPPING

A. Fire-Resistant Sealant: Provide UL Listed firestopping system for filling openings around penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

B. Products: Subject to compliance with requirements, provide products by one of the following:

1. Specified Technologies, Inc.
2. 3M Corporation
3. Metacaulk.
4. Hilti, Inc.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS--COMMON REQUIREMENTS

A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 21 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

C. Install piping at indicated slope.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

K. Install fittings for changes in direction and branch connections.

L. Install couplings according to manufacturer's printed instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, suspended ceilings, cabinet interiors and other exposed locations, according to the following:

1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw, and polished chrome-plated finish. Use split-casting escutcheons, where required, for existing piping.
2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge, spring clips, and chrome-plated finish.
5. Piping in Utility Areas: Cast-brass or stamped-steel, with set-screw or spring clips.

N. Install sleeves for pipes passing through concrete and masonry walls, concrete floor and roof slabs, exterior walls and where indicated.

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.
2. Build sleeves into new walls and slabs as work progresses.
3. Install large enough sleeves to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than 6 inches.
   b. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
   c. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Flashing is specified in Division 7 Section "Flashing and Sheet Metal."
      1) Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.
4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation in non-rated floors and partitions, using elastomeric joint sealants. EXCEPTION: Fire rated partition penetrations shall be sealed with U.L. Listed firestopping systems.

O. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and elastomeric sealant. Size sleeve for ½-inch annular clear space between pipe and sleeve for installation of sealant.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install sheet metal sleeve assembly for sleeves 6 inches and larger.
3. Install material sleeves according to manufacturer’s preprinted instructions.

P. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with U.L. Listed firestopping sealant system.

Q. Verify final equipment locations for roughing in.

R. Refer to equipment specifications in other Sections for roughing-in requirements.

S. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
   a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
   b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
   c. Align threads at point of assembly.
   d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
   e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
4. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to the "Quality Assurance" Article.
5. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

T. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.
2. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION--COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Design Professional.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

3.3 PAINTING AND FINISHING

A. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

B. Paint all exposed steel surfaces of piping and supports with one coat of primer and two coats of enamel.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.5 DEMOLITION

A. Disconnect, demolish, and remove work specified under Division 21 and as indicated.

B. Where pipe, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and equipment in its entirety. Cap existing piping that remains in place.

D. Abandoned Work: Cut and remove pipe abandoned in place, 2 inches beyond the face of adjacent construction. Cap piping and patch surface to match existing finish.

E. Removal: Remove indicated piping and equipment from the Project site unless noted otherwise.

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

G. Remove all hangers, supports and anchors associated with sprinkler items. Patch surfaces to match adjacent finishes.

3.6 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair cut surfaces to match adjacent surfaces.

END OF SECTION 210500

SECTION 210519

GAGES FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes gages used in fire protection systems.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for each type of gage and fitting specified. Include scale range, ratings, and calibrated performance curves, certified where indicated.

1.4 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

B. Design Criteria: The Drawings indicate types, sizes, capacities, ranges, profiles, connections, and dimensional requirements of meters and gages and are based on the specific manufacturer types and models indicated. Meters and gages having equal performance characteristics by other manufacturers may be considered, provided that deviations do not change the design concept or intended performance as judged by the Design Professional. The burden of proof for equality of meters and gages is on the proposer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pressure Gages:
   a. AMETEK, U.S. Gauge Div.
   b. Ashcroft by Dresser Industries, Instrument Div.
   c. Marsh Instrument Co.
   d. Marshalltown Instruments, Inc.
   e. H.O. Trerice Co.
   f. Weiss Instruments, Inc.
   g. Weksler Instruments Corp.
   h. WIKA Instruments Corp.

2.2 PRESSURE GAGES

A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage, with bottom connection.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch -diameter glass lens.

C. Connector: Brass, 1/4-inch.

D. Scale: White-coated aluminum, with permanently etched markings.

E. Accuracy: Plus-or-minus 1 percent of range span.

F. Range: Conform to the following:

1. Fluids Under Pressure: 2 times operating pressure.

2.3 PRESSURE-GAGE ACCESSORIES

A. Snubbers: 1/4-inch brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 GAGE APPLICATIONS

A. General: Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.

3.2 GAGE INSTALLATION, GENERAL

A. Install gages and accessories according to manufacturers' written instructions for applications where used.

3.3 PRESSURE GAGE INSTALLATION

A. Install pressure gages in piping tee with pressure gage valve located on pipe at most readable position. Install in locations indicated on the drawings.

B. Install in the following locations and elsewhere as indicated:

1. At suction and discharge of each pump.
2. At building water service entrance.
3. At floor control valves.

C. Pressure Gage Needle Valves: Install in piping tee with snubber. Install syphon instead of snubber for steam pressure gages.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 21 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install gages adjacent to machines and equipment to allow servicing and maintenance.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of gages to proper angle for best visibility.

B. Cleaning: Clean windows of gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 210519

SECTION 210523

GENERAL DUTY VALVES FOR FIRE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes general duty valves common to several mechanical piping systems.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B31.9 for building services piping valves.
4. AWWA C606 for grooved end connections.

B. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

PART 2 - PRODUCTS

2.1 BASIC, COMMON FEATURES

A. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

B. Sizes: Same size as upstream pipe, unless otherwise indicated. All valves shall be a full port design.

C. Valve Actuator Types:

1. Hand lever: For quarter-turn valves smaller than NPS 4.

D. Threads: ASME B1.20.1.

E. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

F. Grooved End Couplings: Valves with grooved ends may be used in grooved piping applications.

2.2 BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Apollo Flow Controls; Conbraco Industries, Inc.
   c. Hammond Valve.
   d. Jomar Valve.
   e. Legend Valve & Fitting, Inc.
   f. NIBCO INC.
2. Description:
   a. Standard: MSS SP-110 or MSS SP-145.
   b. CWP Rating: 600 psig (4140 kPa).
   c. Body Design: Two piece.
   d. Body Material: Heat treated forged brass.
   e. Ends: Threaded and soldered.
   f. Seats: PTFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel.
   i. Port: Full.

2.3 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Valve, Inc.
2. Apollo Flow Controls; Conbraco Industries, Inc.
3. Crane; Crane Energy Flow Solutions.
4. Hammond Valve.
5. Jomar Valve.
6. Legend Valve & Fitting, Inc.
7. Milwaukee Valve Company.
8. NIBCO INC.

B. Swing Check Valves: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections. Check valve shall have removable cover for servicing.

C. Swing Check Valves: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections. Check valve shall have removable cover for servicing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.

3.3 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.4 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.5 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 220523

SECTION 210529

HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes hangers and supports for fire suppression piping and equipment.

1.3 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for each type of hanger and support.

C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code--Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

C. NFPA Compliance: Comply with NFPA 13 for hangers and supports used as components of fire protection systems.

D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.

E. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.

1. Components include galvanized coatings or alternate rust preventing shop coating.
2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

C. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

D. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

2.2 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, steel plates, shapes, and bars, black and galvanized.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Grout: ASTM C 1107, Grade B, non-shrink, nonmetallic.

1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Water: Potable.
4. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in the Section specifying the equipment and systems.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.

C. Install supports with maximum spacings complying with MSS SP-69.

D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at 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 to forms. Install reinforcing bars through openings at top of inserts.

F. Install concrete inserts in new construction prior to placing concrete.

G. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated Tool Manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

H. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

K. Support all piping direct from structure and independent of other piping.

L. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

M. Load Distribution: Install hangers and supports so that piping live and dead loading and stress from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.

O. Insulated Piping: Comply with the following installation requirements.

P. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.

1. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
2. Shields: Install MSS Type 40, protective shields on insulated piping. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

NPS (Inches)	LENGTH (Inches)	THICKNESS (Inches)
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105

3. Pipes 6 Inches and Larger: Include shield inserts.
4. Insert Material: Length at least as long as the protective shield.
5. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedure(s) for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

C. Paint all exposed steel surfaces with one coat of primer and two coats of enamel.

END OF SECTION 210529

SECTION 210553

IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hydraulic data Signs.
2. Pipe labels.
3. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 HYDRAULIC DATA SIGNS

A. Hydraulic Data Signs for Riser Valves, Alarm Check Valves and Floor Control Valves:

1. Material and Thickness: Aluminum sign with a minimum thickness of 0.020-inch (21 gauge) and having predrilled holes for mounting.
2. Information Box Color: White UV resistant ink.
3. Background Color: Red UV resistant ink.
4. Maximum Temperature: Able to withstand temperatures up to 212 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 5 by 7 inches.
6. Include the following information:
   a. Location
   b. Number of sprinklers.
   c. Density (gpm/sq.ft.)
   d. Design area (sq.ft.)
   e. Gpm discharge (gpm).
   f. Residual pressure (psi)
   g. Hose stream allowance (gpm).
   h. Occupancy classification.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service.

1. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1.5-inch letters.

1. Material: 3/32-inch-thick plastic laminate with black surfaces and a white inner layer.
2. Material: Manufacturer's standard solid plastic.
3. Size: 6 by 3 inches.
4. Shape: Rectangular.
5. Fasteners: Suspend from valve with metal chain.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.

3.3 HYDRAULIC DATA SIGN INSTALLATION

A. Provide sign at each system riser valve, alarm check valve, and floor control valve to provide hydraulic data for information for each sprinkler zone served by the corresponding valve.

B. Install sign on wall adjacent to valve or suspend sign from a chain attached to the valve.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
3. Near major equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Pipe Label Color:

1. Background: Safety red.
2. Letter Colors: White.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems.

END OF SECTION 210553

SECTION 210560

FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes fire-suppression piping and equipment for the following building systems:

1. Automatic wet-type, fire-suppression standpipes and branches for sprinklers.
2. Wet-pipe, fire-suppression sprinklers, including piping, valves, specialties, and automatic sprinklers.

1.3 DEFINITIONS

A. Hose Connection: Valve with threaded outlet matching fire hose coupling thread for attaching fire hose.

B. Hose Station: Hose connection, fire hose rack, and fire hose.

C. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 and NFPA 14 for obtaining approval from authorities having jurisdiction.

D. Q.R.: Quick response.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Design standpipes and sprinklers and obtain approval from authorities having jurisdiction.

B. Design sprinkler piping according to the following and obtain approval from authorities having jurisdiction:

1. Include 10 psi margin of safety for available water pressure.
2. Include losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications: As follows:
   a. Building Service Areas: Ordinary Hazard, Group 1.
   b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c. General Storage Areas: Ordinary Hazard, Group 1.
   d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   e. Office and Public Areas: Light Hazard.
   f. Residential Living Areas: Light Hazard.
   g. Classrooms: Light Hazard.
4. Minimum Density for Automatic-Sprinkler Piping Design: As follows:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area. Area may be reduced as permitted by NFPA 13.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500- sq. ft. area. Area may be reduced as permitted by NFPA 13.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500- sq. ft area. Area may be reduced as permitted by NFPA 13.

C. Components and Installation: Capable of producing piping systems with 175-psig (1200-kPa) minimum working-pressure rating, unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Pipe and fitting materials and methods of joining for standpipe piping.
2. Pipe and fitting materials and methods of joining for sprinkler piping.
3. Pipe hangers and supports.
4. Piping seismic restraints.
5. Valves, including specialty valves, accessories, and devices.
6. Alarm devices. Include electrical data.
7. Hose connections. Include size, type, and finish.
8. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.

B. Fire-Hydrant Flow Test Report: As specified in "Preparation" Article.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction. Include hydraulic calculations, if applicable.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping."

E. Maintenance Data: For each type of standpipe and sprinkler specialty to include in maintenance manual.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.

B. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.

C. Standpipe and Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

E. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:

1. Specialty Valves and Devices:
   a. Anvil International
   b. Globe Fire Sprinkler Corp.
   c. Reliable Automatic Sprinkler Co., Inc.
   d. Viking Corp.
   e. Tyco
2. Water-Flow Indicators and Supervisory Switches:
   a. Anvil International
   b. Gamewell Co.
   c. System Sensor Div.
   d. Potter Electric Signal Co.
   e. Reliable Automatic Sprinkler Co., Inc.
   f. Viking Corp.
3. Sprinkler, Drain and Alarm Test Fittings:
   a. AGF Manufacturing
   b. Globe Fire Sprinkler Corp.
   c. Reliable
   d. Smith-Cooper International; FPPI Div.
   e. Viking Corp.
4. Sprinkler, Inspector's Test Fittings:
   a. AGF Manufacturing
   b. Globe Fire Sprinkler Corp.
   c. Reliable
   d. Smith-Cooper International; FPPI Div.
   e. Viking Corp.
5. Electrically Operated Alarm Bell:
   a. Fire Lite Alarms, Inc.; a Honeywell company
   b. Notifier, a Honeywell company
   c. Potter Electric Signal Company
6. Sprinklers:
   a. Globe Fire Sprinkler Corp.
   b. Reliable Automatic Sprinkler Co., Inc.
   c. Viking Corp.
   d. Tyco
7. Hose Connections:
   a. Elkhart Brass Mfg. Co., Inc.
   b. Guardian Fire Equipment, Inc.
   c. Potter-Roemer Div.
   d. Tyco
8. Indicator Valves:
   a. Anvil International
   b. Kennedy Valve Div.
   c. Mueller
   d. Nibco, Inc.
   e. Stockham Valves & Fittings, Inc.
   f. Victaulic Co. of America

9. Keyed Couplings for Steel Piping:
   a. Anvil International
   b. Grinnell
   c. Gruvlok
   d. Star Pipe Products, Inc.
   e. Victaulic Co. of America.
10. Automatic Air Venting Device:
   a. AGF Manufacturing
   b. Globe Fire Sprinkler Corp.
   c. Potter Signal
   d. Reliable
   e. Viking Corp

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES AND TUBES

A. Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795; Schedule 40 in NPS 2 (DN150) and smaller.

B. Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2-1/2 and larger.

C. Stainless Steel Tubing: UL listed, one-piece flexible tubing system. System assembly shall include couplings and ceiling grid mounting hardware; piping assembly shall be designed for connecting branch piping to sprinklers and mounting sprinklers in ceiling.

2.4 PIPE AND TUBE FITTINGS

A. Cast-Iron Threaded Flanges: ASME B16.1.

B. Cast-Iron Threaded Fittings: ASME B16.4.

C. Malleable-Iron Threaded Fittings: ASME B16.3.

D. Steel, Threaded Couplings: ASTM A 865.

E. Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.

F. Steel Flanges and Flanged Fittings: ASME B16.5.

G. Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 47 (ASTM A 47M), malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

2.5 JOINING MATERIALS

A. Refer to other Division 21 sections for pipe-flange gasket materials and welding filler metals.

B. Steel, Keyed Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts. Include listing for dry-pipe service for couplings for dry piping.

C. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.6 GENERAL-DUTY VALVES

A. Refer to other Division 21 sections for ball, butterfly, globe, and check valves not required to be UL listed and FM approved.

2.7 FIRE-PROTECTION-SERVICE VALVES

A. General: UL Listed and FM approved, with minimum 175-psig non-shock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.

B. Gate Valves, NPS 2 and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.

1. Indicator: Electrical, prewired, supervisory switch. Coordinate requirements with fire alarm system.

C. Indicating Valves, NPS 2-1/2 and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.

1. Indicator: Electrical, prewired, supervisory switch. Coordinate requirements with fire alarm system.

D. Gate Valves, NPS 2-1/2 and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.

E. Swing Check Valves: UL Listed & FM Approved; MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections. Check valve shall have removable cover for servicing.

F. Swing Check Valves: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections. Check valve shall have removable cover for servicing.

2.8 SPRINKLERS

A. Automatic Sprinklers: With heat-responsive element complying with UL199.

B. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Intermediate" temperature classification rating, unless otherwise indicated or required by application.

C. Sprinkler types, features, and options include the following:

1. Concealed ceiling sprinklers, including cover plate.
2. Quick-response sprinklers.
3. Upright sprinklers.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Steel, white finish, one piece, flat.

E. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.9 SPECIALTY SPRINKLER FITTINGS

A. Specialty Fittings: UL Listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.

B. Mechanical-T Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlet.

C. Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gaskets, bolts, and threaded or locking-lug outlets.

D. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.

E. Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.

2.10 SPRINKLER INSPECTOR'S TEST FITTINGS WITH INTEGRAL PRESSURE RELIEF AND DRAIN

A. Standard: UL or FM Global, listing. NFPA 13.

B. Pressure Rating: 300 psig.

C. Body Material: Bronze body, brass stem, steel handle, chrome-plated bronze ball, virgin teflon valve seat.

D. Sight Glass: Bronze housing with viewing window.

E. Components: A tamper resistant test orifice and a tapped port for system access.

F. Pressure Relief Valve and Drainage Piping:

1. Body Material: Bronze body and stainless-steel spring.
2. Components: Nylobraid flexible tube, One 1/2 inch NPT by barbed 90 degree elbow, one ½” NPT by barbed straight adapter, external identification plate and integral flushing handle to remove debris
3. ½-inch MIPT inlet, 1/2 inch FIPT outlet.
4. Relief pressure shall be factory set to project specifications.
5. Relief valve shall operate to the OPEN position between 90% and 105% of the set pressure.
6. Relief valve shall reseat or CLOSE at a minimum of 80% of set pressure.

G. Size: F.I.P.T., same as connected piping.

H. Inlet and Outlet: Threaded.

2.11 HOSE CONNECTIONS

A. Description: UL 668, 300-psig minimum pressure rating, brass, hose valve for connecting fire hose. Include 90-degree angle pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire department threads.

1. Valve Operation: pressure-regulating type.
2. Finish: Rough brass.
3. Finish: Rough chrome plated.

2.12 ALARM DEVICES

A. General: Types matching piping and equipment connections.

B. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

C. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

D. Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

2.13 PRESSURE GAGES

A. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch diameter dial with dial range of 0 to 250 psig.

2.14 AIR VENTING DEVICE

A. Product: Device which automatically vents air from wet pipe sprinkler system.

1. Standard: UL or FM Global, listing. NFPA 13.
2. Pressure Rating: 300 psig, 175 psi for air vent.
3. Body Material: Forged brass body.
4. Components: Ball valve, stainless steel strainer, purge valve with hose connection, thread cap with lanyard, automatic air vent.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article in Part 1 of this Section.

B. Report test results promptly and in writing.

3.2 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PIPING APPLICATIONS

A. Do not use welded joints with galvanized steel pipe.

B. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

C. Standpipes: Use the following:

1. NPS 10 and Smaller: Schedule 10 steel pipe with roll-grooved ends; steel, grooved-end fittings; and grooved joints.
2. NPS 10 and Smaller: Schedule 10 steel pipe with plain ends, steel welding fittings, and welded joints.

D. Wet-Pipe Sprinklers: Use the following:

1. NPS 2 and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
2. NPS 1-1/4 and larger: Schedule 10 steel pipe with roll-grooved ends; steel, grooved-end fittings; and grooved joints.

3. NPS 1-1/4 and larger: Schedule 10 steel pipe with plain ends, steel welding fittings, and welded joints.

3.4 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Fire-Protection-Service Valves: UL Listed and FM approved for applications where required by NFPA 13 and NFPA 14.
   a. Shutoff Duty: Use gate valves.
2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13 and NFPA 14.
   a. Shutoff Duty: Use gate, ball, or butterfly valves.
   b. Throttling Duty: Use globe, ball, or butterfly valves.

3.5 JOINT CONSTRUCTION

A. Refer to other Division 21 sections for basic piping joint construction.

B. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

C. Dissimilar-Piping-Material Joints: Construct joints using adapters or couplings compatible with both piping materials. Use dielectric fittings if both piping materials are metal. Refer to other Division 21 sections for dielectric fittings.

3.6 WATER-SUPPLY CONNECTION

A. Connect standpipe and sprinkler piping to existing sprinkler supply piping.

3.7 PIPING INSTALLATION

A. Refer to other Division 21 sections for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Design Professional before deviating from approved working plans.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install pressure relief valves. Route pressure relief valve outlet to system drain piping.

I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install drain valves on standpipes.

K. Install alarm devices in piping systems.

L. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping and to NFPA 14 for standpipes.

M. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.

N. Install flexible stainless-steel tubing systems in accordance with the manufacturer’s instructions.

O. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.

P. Install automatic air venting device at high point of wet pipe sprinkler systems.

3.8 SPECIALTY SPRINKLER FITTING INSTALLATION

A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.9 VALVE INSTALLATION

A. Refer to other Division 21 sections for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13 and NFPA 14, manufacturer's written instructions, and authorities having jurisdiction.

B. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection.

D. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.

3.10 SPRINKLER APPLICATIONS

A. General: Use sprinklers according to the following applications:

1. Rooms without Ceilings: Q.R. upright sprinklers.
2. Rooms with Suspended Ceilings: Q.R. concealed sprinklers.
3. Wall Mounting: Q.R. sidewall sprinklers.
4. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
5. Sprinkler Finishes: Use sprinklers with the following finishes:
    a. Upright Sprinklers: Rough bronze in unfinished spaces not exposed to view.
    b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

3.11 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.12 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes, unless otherwise indicated.

B. Install freestanding hose connections for access and minimum passage restriction.

3.13 CONNECTIONS

A. Connect water supplies to standpipes and sprinklers.

B. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

C. Electrical Connections: Power wiring is specified in Division 26.

D. Connect alarm devices to fire alarm.

3.14 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and in other Division 21 sections.

3.15 FIELD QUALITY CONTROL

A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

B. Flush, test, and inspect standpipes according to NFPA 14, "Tests and Inspection" Chapter.

C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

D. Report test results promptly and in writing to the Design Professional and authorities having jurisdiction.

3.16 CLEANING

A. Clean dirt and debris from sprinklers. Where adhesive materials such as paint and drywall mud have adhered to sprinklers, they shall be replaced entirely.

B. Remove and replace sprinklers having paint other than factory finish.

3.17 PROTECTION

A. Protect sprinklers from damage until Material Completion.

3.18 COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that air compressors and their accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

F. Verify that hose connections have threads compatible with local fire department equipment.

G. Fill wet-pipe sprinkler piping with water.

H. Fill standpipes with water.

I. Verify that hose connections are correct type and size.

J. Energize circuits to electrical equipment and devices.

K. Adjust operating controls and pressure settings.

L. Coordinate with fire alarm tests. Operate as required.

M. Coordinate with fire-pump tests. Operate as required.

3.19 DEMONSTRATION

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with Owner with at least seven days' advance notice.

END OF SECTION 210560

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SECTION 220000

GENERAL PLUMBING PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes general provisions covering the contract documents for Plumbing Systems.

1.3 DEFINITIONS

A. Provide shall mean "Furnish, install and connect."

B. Piping shall mean "pipe installed with all specified fittings, valves and accessories, and forming a complete system."

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Electrical Coordination: In addition to submittal requirements of other Division 22 Sections, submit a document approved by the project Electrical Contractor certifying that all mechanical equipment being furnished under Division 22 complies with the electrical characteristics of the source power which will be furnished under Divisions 26 and 27.

C. Model numbers listed on the Mechanical Contract Documents shall not be construed to indicate electrical characteristics. Electrical characteristics of mechanical equipment shall be as indicated on the Electrical Contract Documents (Division 26).

D. Review of Submittals does not relieve the Contractor of any of the requirements of the Contract Documents. Failure by the Engineer to document errors and omissions in the Contractor's submittals during the Engineer's submittal review does not constitute a waiver of any of the requirements of the original sealed Contract Documents.

1.5 CONTRACTOR QUALIFICATIONS

A. Plumbing Subcontractor shall have a Class II Unlimited License and shall have demonstrated proficiency in the installation of plumbing systems by the successful installation of systems similar to those included in the Construction Documents for this project. Such systems shall have been installed in commercial or institutional buildings having a minimum of 150 plumbing fixtures (in a single building). The Subcontractor shall have been in business as described above for a minimum period of five years.

B. A master or journeyman plumber shall be present at the site during the installation of all plumbing related work. The master or journeyman plumber shall be certified in the state in which the construction is being performed and shall have his license present at site or on file during construction.

1.6 PRIOR APPROVALS

A. Manufacturers References: When reference is made in the Contract Documents to trade names or specific manufacturers and/or models, such reference, unless noted otherwise, is made to designate and identify the quality of materials or equipment to be furnished and is not intended to restrict competitive bidding. If it is desired to use materials or equipment different from those indicated on the Contract Documents, written request for approval must reach the hands of the Primary Design Professional at least TEN DAYS prior to the date set for the opening of bids. A copy of the request should also be sent directly to the Engineer. Requests for prior approval of a proposed substitute shall be accompanied by complete technical data supporting the request.

1.7 LAYOUT AND COORDINATION

A. Layout Basis:

1. The equipment listed on the Drawings and in the Specifications has been used for the physical arrangement of the mechanical systems. When equipment listed as acceptable, equal or equipment which has received "prior approval" is used, it shall be the Contractor's responsibility to provide structural, ductwork, electrical, service clearances, or other changes required to accommodate the substituted equipment. Changes shall be made at no additional cost to the Owner. Submit a list of required changes along with all prior approval requests and shop drawing submittals.
2. The Contract Drawings are intended to show the general arrangement of all mechanical work. They do not show in detail all offsets, fittings and transitions. Examine Drawings, investigate site conditions to be encountered and arrange work accordingly. Furnish all offsets and transitions required.
3. Drawings do not indicate in detail exact configuration of connections for fixtures, equipment and accessories. Final connection shall be as shown on approved Manufacturer's Submittal Drawings. Where Manufacturer's Submittal Drawings conflict with the Contract Documents, confer with the Design Professional for resolution.
4. Measurement of Drawings by scale shall not be used as dimensions for fabrication. Measurements for locating fixtures, equipment, ductwork, piping and other mechanical items shall be made on the site and shall be based on actual job conditions.
5. Check space limitations and verify electrical requirements before ordering any mechanical equipment or materials. Place large equipment inside the building prior to the erection of exterior walls where equipment cannot enter finished building openings.

B. Coordination: Mechanical work shall be coordinated with that of other trades to avoid conflict. The Contractor shall study all plans and specifications for this project and shall notify the Design Professional of any conflict between work under Division 22 and work under other divisions of the Project. Particular attention shall be given to interference between piping, electrical installations, structural systems, building openings and ductwork.

C. Installation Instructions: Manufacturer's installation instructions for all equipment furnished under Division 22 shall be furnished by the Contractor. Instructions shall be maintained on the jobsite until the project is complete, and then turned over to the Owner.

D. Operation and Maintenance Instructions: Electronic copies of equipment O&M manuals shall be submitted to the Owner a minimum of 15 days prior to equipment/systems training. An index document indicating project name, project number, building name and contents shall be included. Model and serial numbers of equipment shall be shown on the cover of their respective O&M manual(s). Warranty registration documentation shall be included where applicable, including documentation confirming warranties have been registered with the equipment manufacturer.

1.8 PERMITS

A. Obtain all necessary Permits and Inspections required for the installation of this work and pay all charges incident thereto. Deliver to the Design Professional all certificates of inspection issued by authorities having jurisdiction.

B. Sewer tap fees, water tap fees, meter fees, Dept. of Labor Fees for Boilers and Pressure Vessels and all other charges for work under Division 22, including charges for meter installation and excess service by the Gas Company or any other utilities shall be paid by the Contractor.

1.9 SAFETY

A. OSHA Requirements applicable to the project shall be complied with at all times.

B. Manufacturer's Safety Instructions shall be followed in all instances.

C. Asbestos Containing Materials (ACM) shall not be used on this project.

D. Refrigerants containing CFC’s or HCFC’s shall not be used on this project, nor shall any equipment using such refrigerants be incorporated into this project.

E. Electrical Equipment Clearances: Piping, equipment and other mechanical installations shall not be located within 42" of the front or 36" of the side of any electrical switchboards, panelboards, power panels, motor control centers, electrical transformers or similar electrical equipment. Piping and ductwork shall not pass through or above electrical equipment rooms except as required to serve those rooms.

F. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof or grade below. The guard shall extend not less than 30 inches beyond each end of such appliances, equipment, fans, components and roof hatch openings and the top of the guard shall be located not less than 42 inches above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21 inch diameter sphere and shall comply with the loading requirements for guards specified in the International Building Code.

1.10 PROTECTION OF PLUMBING SYSTEMS DURING CONSTRUCTION

A. Material storage:

1. All materials and equipment stored on the jobsite shall be elevated above the ground and stored under suitable weather cover. Materials and equipment shall not be situated in areas subjected to localized flooding.
2. Manufacturer’s original shipping packaging and protective coverings shall be left in place until the equipment is prepared for installation.

B. Roof protection: All penetrations through roofs, including roof vents and roof drainage system elements shall be properly protected during construction to prevent water intrusion into the building. Protective measures could include temporary covers and plugs, as well as other appropriate temporary elements.

C. Electrical enclosure protection

1. During construction, all protective covers and other devices shall be left in place that protect against inadvertent contact with live electrical circuits.
2. All warning labels related to electrical and rotating equipment hazards shall be in place prior to energizing mechanical equipment circuits.

D. Protection of equipment and piping

1. Maintain temporary closures on the ends of all equipment and pipes as the installation work progresses. Temporary closures include plastic sheeting, tape and appropriate caps and covers.
2. Where debris enters piping during installation, steps shall be taken to clean the interior of the pipe prior to placing in service.
3. Where debris enters equipment during installation the duct interior shall be cleaned prior to placing in service.

1.11 CODES AND STANDARDS

A. Mechanical installations shall conform to the current edition (recognized by the State) of the following, in addition to any previously mentioned Codes and Standards.

1. The International Building Code.
2. The International Mechanical Code.
3. The International Plumbing Code.
4. The International Fire Protection Code.
5. The State Energy Code.
6. NFPA Standard 70, National Electric Code.
7. NFPA Standard 101, Code for Safety to Life for Fire in Buildings and Structures.

1.12 ASBESTOS MATERIALS

A. Contractor is advised there may be ASBESTOS PRODUCTS in building(s) which will affect work under this Project. Particular reference is made to piping, equipment and other items that may be modified or removed. It shall be the sole responsibility of Contractor to check for and ascertain presence of asbestos materials where such presence affects work under this Project. Where Contractor ascertains presence of asbestos materials, he shall notify Owner and Engineer in writing of presence of asbestos BEFORE beginning any work. Removal of asbestos products shall be the responsibility of Owner AFTER he has been notified by Contractor of its presence.

B. Engineer assumes no responsibility of investigating for presence of ASBESTOS PRODUCTS or for verifying presence of asbestos materials, nor does Engineer assume any responsibility for specifying, advising on, or supervising removal of any asbestos products. Contractor and Owner shall hold harmless Engineer in any matters involving presence of, or removal of, asbestos products.

1.13 INTERRUPTION OF EXISTING SERVICES

A. Exercise care so as not to cut any existing utilities or services. Where an existing utility line or service line is cut it shall be repaired to "like-new" condition. Interruption of service shall not be made without prior written permission of the Owner.

B. Plumbing system must remain in service during construction. Arrange with the Owner well in advance of shutdowns required for tie-ins. Shutdowns shall be made after normal occupancy hours if so directed by the Owner. No additional monies will be paid for after-hours shutdowns.

PART 2 - PRODUCTS Not required for this section.

PART 3 – EXECUTION Not required for this section.

END OF SECTION 220000

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SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 22 sections.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete equipment base construction requirements.
3. Field-fabricated metal and wood equipment supports.
4. Installation requirements common to equipment specification Sections.
5. Mechanical demolition.
6. Cutting and patching.
7. Touchup painting and finishing.

B. Pipe and pipe fitting materials are specified in piping system Sections.

1.3 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Shop drawings detailing fabrication and installation for metal supports and anchorage for mechanical materials and equipment.

C. Coordination drawings for access panel and door locations.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code--Steel."

B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

C. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

D. Coordinate all electrical service requirements for mechanical equipment prior to the submittal of shop drawings. Confirm the compatibility of all power services with the equipment being furnished. Confirm compatibility of electrical lugs being provided by the equipment manufacturer with the power wiring being furnished under Division 26. Furnish written documentation that all characteristics have been coordinated with and confirmed by the electrical subcontractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 22 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch minimum thickness, except where thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face, 1/8-inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Plastic Pipe Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, except where other type or material is indicated.

E. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.

F. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements: Manufacturer's standard solvents complying with the following:

1. Poly (Vinyl Chloride) (PVC): ASTM D 2564.

I. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47, Grade 32510 or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.3 PIPING SPECIALTIES

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube, and insulation.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.
   a. Finish: Polished chrome plate.
4. Cast Brass: Split casting, with concealed hinge and set-screw.
   a. Finish: Polished chrome plate.
5. Stamped Steel: One-piece, with set-screw and chrome-plated finish.
6. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.
7. Stamped Steel: Split plate, with exposed-rivet hinge, set-screw, and chrome-plated finish.
8. Cast-Iron Floor Plate: One-piece casting.

B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly for 250-psig minimum working pressure at a 180 deg F temperature.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.
6. Dielectric Couplings: Galvanized-steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F temperature.
7. Dielectric Nipples: Electroplated steel nipple, having inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225 deg F temperature.

C. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast-Iron: Cast or fabricated wall pipe equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.
4. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.
   a. Penetrating Pipe Deflection: 5 percent without leakage.
   b. Housing: Ductile-iron casting having water-stop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.

c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
d. Housing-to-Sleeve Gasket: Rubber or neoprene push-on type of manufacturer's design.

5. Cast-Iron Sleeve Fittings: Commercially made sleeve having an integral clamping flange, with clamping ring, bolts, and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

2.4 FIRE-STOPPING

A. Fire-Resistant Sealant: Provide UL Listed firestopping system for filling openings around penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

B. Products: Subject to compliance with requirements, provide products by one of the following:

1. Specified Technologies, Inc.
2. 3M Corporation
3. Metacaulk.
4. Hilti, Inc.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS--COMMON REQUIREMENTS

A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 22 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

C. Install piping at indicated slope.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

K. Install fittings for changes in direction and branch connections.

L. Install couplings according to manufacturer's printed instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, suspended ceilings, cabinet interiors and other exposed locations, according to the following:

1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw, and polished chrome-plated finish. Use split-casting escutcheons, where required, for existing piping.
2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge and chrome-plated finish.
5. Piping in Utility Areas: Cast-brass or stamped-steel, with set-screw clips.

N. Install sleeves for pipes passing through concrete and masonry walls, concrete floor and roof slabs, exterior walls and where indicated.

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.
2. Build sleeves into new walls and slabs as work progresses.
3. Install large enough sleeves to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than 6 inches.
   b. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
   c. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
      1) Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.
4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation in non-rated floors and partitions, using elastomeric joint sealants. EXCEPTION: Fire rated partition penetrations shall be sealed with U.L. Listed firestopping systems.

O. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and elastomeric sealant. Size sleeve for ½-inch annular clear space between pipe and sleeve for installation of sealant.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install sheet metal sleeve assembly for sleeves 6 inches and larger.
3. Install cast iron sleeves according to manufacturer’s preprinted instructions.

P. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

Q. Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer's printed installation instructions.

R. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with U.L. Listed firestopping sealant system.

S. Verify final equipment locations for roughing in.

T. Refer to equipment specifications in other Sections for roughing-in requirements.

U. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS "Soldering Manual," Chapter 22 "The Soldering of Pipe and Tube."
4. Brazed Joints: Construct joints according to AWS "Brazing Manual" in the "Pipe and Tube" chapter.
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
   a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
   b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
   c. Align threads at point of assembly.
   d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
   e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
6. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to the "Quality Assurance" Article.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
8. Plastic Pipe and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following standards:
   a. Comply with ASTM F 402 for safe handling of solvent-cement and primers.
   b. Poly (Vinyl Chloride) (PVC) Pressure Application: ASTM D 2672.
   c. Poly (Vinyl Chloride) (PVC) Non-Pressure Application: ASTM D 2855.

V. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.
2. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION--COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Design Professional.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

3.3 PAINTING AND FINISHING

A. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

B. Paint all exposed steel surfaces of piping and supports with one coat of primer and two coats of enamel.

3.4 CONCRETE BASES

A. Construct concrete equipment bases of dimensions indicated, but not less than 4 inches larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive strength concrete with 6 x 6 x #10 reinforcing wire mesh. Outdoor concrete bases shall extend a minimum of 4" above grade and be a minimum thickness of 6".

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.6 DEMOLITION

A. Disconnect, demolish, and remove work specified under Division 22 sections and as indicated.

B. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety. Cap existing piping and ductwork that remains in place.

D. Abandoned Work: Cut and remove pipe abandoned in place, 2 inches beyond the face of adjacent construction. Cap piping and patch surface to match existing finish.

E. Removal: Remove indicated equipment, piping and ductwork from the Project site unless noted otherwise

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

G. Remove all hangers, supports and anchors associated with mechanical items be removed. Patch surfaces to match adjacent finishes.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair cut surfaces to match adjacent surfaces.

END OF SECTION 220500

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SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes meters and gages used in plumbing systems.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves.

1.4 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

B. Design Criteria: The Drawings indicate types, ranges, profiles and connections requirements of meters and gages and are based on the specific manufacturer types and models indicated. Meters and gages having equal performance characteristics by other manufacturers may be considered, provided that deviations do not change the design concept or intended performance as judged by the Design Professional. The burden of proof for equality of meters and gages is on the proposer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Liquid-in-Glass Thermometers:
   a. Marsh Instrument Co.
   b. Marshalltown Instruments, Inc.
   c. H.O. Trerice Co.
   d. Weiss Instruments, Inc.
   e. Weksler Instruments Corp.
2. Pressure Gages:
   a. AMETEK, U.S. Gauge Div.
   b. Ashcroft by Dresser Industries, Instrument Div.
   c. Marsh Instrument Co.
   d. Marshalltown Instruments, Inc.
   e. H.O. Trerice Co.
   f. Weiss Instruments, Inc.
   g. Weksler Instruments Corp.
   h. WIKA Instruments Corp.

2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed as follows:

1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

B. Accuracy: Plus-or-minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Description: ASTM E 1, liquid-in-glass thermometer.

B. Case: Die-cast aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red-reading, organic liquid-filled with magnifying lens.

E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.

F. Stem: Copper-plated, steel, aluminum, or brass for a separable socket of length to suit installation.

2.4 THERMOMETER WELLS

A. Description: Brass or stainless-steel thermometer well.

B. Pressure Rating: Not less than piping system design pressure.

C. Stem Length: To extend to center of pipe.

D. Extension for Insulated Piping: 2 inches nominal, but not less than thickness of insulation.

2.5 PRESSURE GAGES

A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage, with bottom connection.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch -diameter glass lens.

C. Connector: Brass, 1/4-inch.

D. Scale: White-coated aluminum, with permanently etched markings.

E. Accuracy: Plus-or-minus 1 percent of range span.

F. Range: Conform to the following:

1. Fluids Under Pressure: 2 times operating pressure.

2.6 PRESSURE-GAGE ACCESSORIES

A. Snubbers: 1/4-inch brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 METER AND GAGE APPLICATIONS

A. General: Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.

3.2 METER AND GAGE INSTALLATION, GENERAL

A. Install meters, gages, and accessories according to manufacturers' written instructions for applications where used.

3.3 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions. Install in the locations indicated on the drawings.

B. Install in the following locations and elsewhere as indicated:

1. At inlet and outlet of each thermal storage tank, water heater or mixing valve.

C. Thermometer Wells: Install in vertical position in piping tees where thermometers are indicated.

1. Install wells with stem extending to center of pipe.
2. Fill wells with oil or graphite and secure caps.

3.4 PRESSURE GAGE INSTALLATION

A. Install pressure gages in piping tee with pressure gage valve located on pipe at most readable position. Install in locations indicated on the drawings.

B. Install in the following locations and elsewhere as indicated:

1. At building water service entrance.

C. Pressure Gage Needle Valves: Install in piping tee with snubber. Install syphon instead of snubber for steam pressure gages.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install meters and gages adjacent to machines and equipment to allow servicing and maintenance.

3.6 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

C. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 220519

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SECTION 220523

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes general duty valves common to several mechanical piping systems.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

C. Maintenance data for valves to include in the operation and maintenance manual. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. Valve solder-joint connections are common in smaller sizes of plumbing piping. Soldering and brazing methods used to achieve required pressure-temperature ratings may damage internal valve parts. Special installation requirements for soldered valves may make threaded valves more cost-effective.
4. Caution: Use solder with melting point below 421 deg F (216 deg C).
5. ASME B16.18 for solder-joint connections.
6. ASME B16.51 for press-fit connections.
7. ASME B31.9 for building services piping valves.

B. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

C. Bronze and brass valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted unless the alloy is heat treated.

D. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.

4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 BASIC, COMMON FEATURES

A. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

B. Sizes: Same size as upstream pipe, unless otherwise indicated. All valves shall be a full port design.

C. Valve Actuator Types:

1. Hand lever: For quarter-turn valves smaller than NPS 4 (DN 100).

D. Valves in Insulated Piping:

1. Include 2-inch (50-mm) stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.

E. Threads: ASME B1.20.1.

F. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

G. Solder Joint: ASME B16.18.

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for check valves; below 421 deg F for ball valves.

2.2 BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Stainless Steel Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Apollo Flow Controls; Conbraco Industries, Inc.
   c. Hammond Valve.
   d. Jomar Valve.
   e. Legend Valve & Fitting, Inc.
   f. Milwaukee Valve Company.
   g. Nibco Inc.
   h. Watts.
2. Description:
   a. Standard: MSS SP-110 or MSS SP-145.
   b. CWP Rating: 600 psig (4140 kPa).
   c. Body Design: Two piece.
   d. Body Material: Heat treated forged brass.
   e. Ends: Threaded and soldered.

f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

B. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Press-Fit Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Apollo Flow Controls; Conbraco Industries, Inc.
   c. Hammond Valve.
   d. Jomar Valve.
   e. Legend Valve & Fitting, Inc.
   f. Milwaukee Valve Company.
   g. Nibco Inc.
   h. Watts.
2. Description:
   a. Standard: MSS SP-110 or MSS SP-145.
   b. CWP Rating: Minimum 250 psig (1724 kPa).
   c. Body Design: Two piece.
   d. Body Material: Heat treated forged brass.
   e. Ends: Press-fit.
   f. Press Ends Connections Rating: Minimum 250 psig (1724 kPa).
   g. Seats: PTFE or RPTFE.
   h. Stem: Stainless Steel.
   i. Ball: Stainless Steel.
   j. Port: Full.
   k. O-Ring Seal: Buna-N or EPDM.

C. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Flow Controls; Conbraco Industries, Inc.
   b. Hammond Valve.
   c. Jomar Valve.
   d. Milwaukee Valve Company.
   e. Nibco Inc.
   f. Watts.
2. Description:
   a. Standard: MSS SP-110 or MSS SP-145.
   b. CWP Rating: Minimum 600 psig (1724 kPa).
   c. Body Design: Two piece.
   d. Body Material: Bronze.
   e. Ends: Press.
   f. Press Ends Connections Rating: Minimum 250 psig (1724 kPa).
   g. Seats: PTFE or RPTFE.
   h. Stem: Stainless Steel.
   i. Ball: Stainless Steel.
   j. Port: Full.
   k. O-Ring Seal: Buna-N or EPDM.

2.3 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Valve, Inc.
2. Apollo Flow Controls; Conbraco Industries, Inc.
3. Hammond Valve.
4. Jomar Valve.
5. Milwaukee Valve Company.
6. Nibco Inc.
7. Watts.

B. Swing Check Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:

C. Swing Check Valves, 3 Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

D. Lift Check Valves: Class 125, ASTM B 62 bronze body and cap (main components), horizontal or vertical pattern, lift-type, bronze disc or Buna N rubber disc with stainless-steel holder threaded or soldered end connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Lift Check Valve: With stem upright and plumb.

H. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

I. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

J. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

K. Press-Connect Joints for Copper Tubing: Join copper tube and pressure-connect fittings with tools recommended by fitting manufacturer.

1. Mark proper insertion depth prior to making press connection.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

M. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 4 Inches and Smaller: Solder ends or threaded ends.

B. Press-fit valve ends may be substituted in press-fit piping applications.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 4 Inches and Smaller:

1. Brass ball valves, two-piece with full port and stainless-steel trim. Provide with threaded, solder or press-fit joint ends.
2. Bronze ball valves, two-piece with full port and stainless-steel trim. Provide with threaded, solder or press-fit joint ends.

3.5 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 220523

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SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical systems piping and equipment.

1.3 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

1.4 PERFORMANCE REQUIREMENTS

A. Design seismic restraint hangers and supports, for piping and equipment.

1.5 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for each type of hanger and support.

C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

1.6 QUALITY ASSURANCE

A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code--Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

C. NFPA Compliance: Comply with NFPA 13 for hangers and supports used as components of fire protection systems.

D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.

E. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.

1. Components include galvanized coatings or alternate rust preventing shop coating.
2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

C. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

D. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

2.2 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, steel plates, shapes, and bars, black and galvanized.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Grout: ASTM C 1107, Grade B, non-shrink, nonmetallic.

1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Water: Potable.
4. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in the Section specifying the equipment and systems.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.

C. Install supports with maximum spacings complying with MSS SP-69.

D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at 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 to forms. Install reinforcing bars through openings at top of inserts.

F. Install concrete inserts in new construction prior to placing concrete.

G. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated Tool Manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

H. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

K. Support all piping direct from structure and independent of other piping.

L. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

M. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.

O. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
3. Shields: Install MSS Type 40, protective shields on insulated piping. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

NPS (Inches)	LENGTH (Inches)	THICKNESS (Inches)
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105

4. Pipes 6 Inches and Larger: Include shield inserts.
5. Insert Material: Length at least as long as the protective shield.
6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

B. Grouting: Place grout under supports for equipment and make a smooth bearing surface.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedure for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without under-cut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

C. Paint all exposed steel surfaces with one coat of primer and two coats of enamel.

END OF SECTION 220529

SECTION 220553

DENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags on ceiling t-bars.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 4 by 3/4 inch (102 by 19 mm).
6. Minimum Letter Size: 1/2 inch (13 mm).
7. Fasteners: Stainless-steel rivet, self-tapping screws or adhesive.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to [partially cover] [cover full] circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters.

1. Material: 3/32-inch-thick plastic laminate with black surfaces and a white inner layer.
2. Material: Manufacturer's standard solid plastic.
3. Size: 4 by 3/4 inch (102 by 19 mm).
4. Shape: Rectangular. Fasteners: Stainless-steel rivet, self-tapping screws or adhesive.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Install on ceiling t-bars below above-ceiling equipment.

3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1 on each piping system.

1. Identification Paint: Use for contrasting background.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

C. "Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. The colors listed in subparagraphs below comply with color designations according to ASME A13.1. Background and lettering colors should comply with recommendations in ASME A13.1 unless otherwise indicated. Note also that all colors listed in ASME A13.1 preceded by the word "Safety" are required to comply with ANSI Z535.1.
2. Domestic Water Piping
   a. Background: Safety green.
   b. Letter Colors: White.
3. Natural Gas Piping:
   a. Background: Safety green.
   b. Letter Colors: White.

3.5 VALVE-TAG INSTALLATION

A. Install labels on ceiling t-bars below above-ceiling valves.

END OF SECTION 220553

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SECTION 220700

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and equipment insulation.

1.3 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 deg F.

D. Thermal resistivity is designated by an r-value that represents the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivity (r-value) is expressed by the temperature difference in degrees Fahrenheit between the two exposed faces required to cause 1 BTU per hour to flow through 1 square foot at mean temperatures indicated.

E. Thermal Conductivity (k-value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of Btu x inch/h x sq. ft. x deg F.

F. Density: Is expressed in lb./cu.ft.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract.

B. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories. Provide a summary in schedule form of intended insulation material, jacket type, thickness and adhesive type for each pipe, duct or equipment using manufacturer's nomenclature.

1.5 QUALITY ASSURANCE

A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

1.6 SEQUENCING AND SCHEDULING

A. Schedule insulation application after testing of piping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Glass Fiber:
   a. CertainTeed Corporation.
   b. Knauf Fiberglass GmbH.
   c. Manville.
   d. Owens-Corning Fiberglas Corporation.
   e. USG Interiors, Inc. - Thermafiber Division.
2. Flexible Elastomeric Cellular:
   a. Armaflex; Armacell LLC
   b. Halstead Industrial Products.
   c. K-Flex; Nomaco K-Flex Corporation.
   d. Aerocel; Aeroflex USA, inc.

2.2 GLASS FIBER

A. Material: Inorganic glass fibers, bonded with a thermosetting resin.

B. Jacket: All-purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.

C. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, jacketed.

1. Thermal Conductivity: 0.26 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F mean temperature.
2. Density: 3 pcf minimum.

D. Adhesive: Produced under the UL Classification and Follow-up service.

1. Type: Non-flammable, solvent-based.
2. Service Temperature Range: Minus 20 to 180 deg F.

2.3 FLEXIBLE ELASTOMERIC CELLULAR

A. Material: Flexible expanded closed-cell structure with smooth skin on both sides.

1. Tubular Materials: ASTM C 534, Type I.
2. Sheet Materials: ASTM C 534, Type II.

B. Thermal Conductivity: 0.30 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F.

C. Coating: Water based latex enamel coating recommended by insulation manufacturer.

D. Fire Performance Characteristics: Provide material having the following fire performance characteristics as determined by UL in accordance with ASTM Standard E84:

1. Flame Spread = 25
2. Smoke Developed = 50

2.4 INSULATING CEMENTS

A. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: ASTM C 449.

1. Thermal Conductivity: 1.2 Btu x inch/h x sq. ft. x deg F average maximum at 400 deg F mean temperature.
2. Compressive Strength: 100 psi at 5 percent deformation.

2.5 ADHESIVES

A. Flexible Elastomeric Cellular Insulation Adhesive: Solvent-based, contact adhesive recommended by insulation manufacturer.

B. Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:

1. Class 1, Grade A for sealing edges of glass fiber insulation.

2.6 JACKETS

A. General: ASTM C 921, Type 1, except as otherwise indicated.

B. Foil and Paper Jacket: Laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

1. Water Vapor Permeance: 0.02 perm maximum, when tested according to ASTM E 96.
2. Puncture Resistance: 50 beach units minimum, when tested according to ASTM D 781.

C. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20 mil thick, high-impact, ultra-violet-resistant PVC.

1. Adhesive: As recommended by insulation manufacturer.

2.7 SEALING COMPOUNDS

A. Vapor Barrier Compound: Water-based, fire-resistive composition.

1. Water Vapor Permeance: 0.08 perm maximum.
2. Temperature Range: Minus 20 to 180 deg F.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

3.2 INSTALLATION, GENERAL

A. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.

B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.

C. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 60 deg F.

D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

K. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:

1. Vibration control devices.
2. Testing laboratory labels and stamps.
3. Nameplates and data plates.
4. Sanitary drainage and vent piping. (Drainage piping receiving air conditioning condensate shall be insulated.)
5. Drainage piping located in crawl spaces, unless indicated otherwise.
6. Below grade piping except for hot water piping.
7. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.

3.3 PIPE INSULATION INSTALLATION, GENERAL

A. Tightly butt longitudinal seams and end joints. Bond with adhesive.

B. Stagger joints on double layers of insulation.

C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.

D. Apply insulation with a minimum number of joints.

E. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Cover circumferential joints with butt strips, at least 3 inches wide, and of same material as insulation jacket. Secure with adhesive and outward clinching staples along both edges of butt strip and space 4 inches on center.
3. Longitudinal Seams: Overlap seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
   a. Exception: Do not staple longitudinal laps on insulation applied to piping systems with surface temperatures at or below 35 deg F.
4. Vapor Barrier Coatings: Where vapor barriers are indicated, apply on seams and joints, over staples, and at ends butt to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor barrier coating.
6. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Adhere, staple, and seal. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.

F. Wall and Partition Penetration: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

G. Fire-Rated Walls and Partitions Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with a U.L. Listed firestopping or fire-resistant joint sealer.

H. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.

I. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with vapor barrier coating. Apply pre-molded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive.

1. Use same material and thickness as adjacent pipe insulation.
2. Overlap nesting insulation by 2 inches or 1-pipe diameter, whichever is greater.
3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.
4. Insulate elbows and tees smaller than 3 inches pipe size with pre-molded insulation.
5. Insulate elbows and tees 3 inches and larger with pre-molded insulation or insulation material segments. Use at least 3 segments for each elbow.
6. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.
7. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments."

3.4 GLASS FIBER PIPE INSULATION INSTALLATION

A. Bond insulation to pipe with lagging adhesive.

B. Seal exposed ends with lagging adhesive.

C. Seal seams and joints with vapor barrier compound.

3.5 FLEXIBLE ELASTOMERIC CELLULAR PIPE INSULATION INSTALLATION

A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, cut one side longitudinally and apply to the pipe. Seal seams and joints with adhesive.

B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive.

1. Miter cut materials to cover soldered elbows and tees.
2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

3.6 JACKETS

A. Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1-1/2 inches laps at longitudinal joints and 3-inch-wide butt strips at end joints.

1. Seal openings, punctures, and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound (mastic) and glass tape (glassfab).

3.7 FINISHES

A. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply 2 coats of protective coating to exposed exterior insulation.

3.8 APPLICATIONS

A. General: Materials and thicknesses are specified in schedules at the end of this Section.

B. Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Domestic cold water.
2. Storm water. Insulate roof drain bodies and above slab rainwater leaders of storm water piping. Includes piping associated roof drains, secondary roof drains and emergency roof drains.
3. Domestic hot water.
4. Recirculated hot water.
5. Drains and sanitary P-traps receiving air conditioning condensate.

3.9 PIPE INSULATION SCHEDULES

A. Schedules:

1. Domestic Cold-Water Piping (including makeup water piping): 1" rigid fiberglass insulation with vapor barrier.
2. Domestic Hot Water and Recirculation Piping:
   a. 1" rigid fiberglass insulation for piping 1-1/4" and smaller.
3. Underground Hot Water Piping:
   a. 1" flexible elastomeric fiberglass insulation for piping 1-1/4" and smaller.
4. Storm Drainage Piping: 1" rigid fiberglass insulation.
   a. Insulate roof drain bodies with 1/2" flexible elastomeric sheets.

END OF SECTION 220700

SECTION 221116

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Piping and fittings.
2. Piping joining materials.
3. Transition fittings.
4. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify [Architect] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of water service.
2. Do not interrupt water service without written permission.

1.6 WARRANTY

A. Special Limited Warranty: For press-connect fitting and valves, include manufacturer’s standard warranty for the following:

1. Warranty Period for Press-Connect Fittings: 50 years from date of Substantial Completion.
2. Warranty Period for Press-Connect Valves: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B88, Type L (ASTM B88M, Type B) water tube, drawn temper.

B. Soft Copper Tube: ASTM B88, Type K (ASTM B88M, Type A) water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint, press-connect, or threaded ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Press-Connect Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Flow Controls; Conbraco Industries, Inc., ApolloXpress.
   b. NIBCO INC.
   c. Viega LLC, Propress.
2. Fittings for NPS 2 (DN 50) and Smaller: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
4. NPS 2-1/2 thru NPS 4 (DN 65 to DN 100) Fittings: Stainless steel grip ring and EPDM O-ring seal in each end.
5. Press Ends: Un-pressed fitting identification feature to the fitting wall.
6. Sealing Element: EPDM.

H. Cast Copper Alloy Pipe Flanges with Press-Connect Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC; ProPress Copper or comparable products by one of the following:
   a. NIBCO INC.
   b. Viega LLC, Propress
2. For Types K, L, and M hard copper tubing NPS 1/2 to NPS 4 (DN 15 to DN 100) and soft copper tubing in NPS 1 to NPS 1-1/4 (DN 25 to DN 32).
3. Flanges: ASME B 16.24, Class 150, powder coated steel plate; two-piece design.
4. NPS 2-1/2 thru NPS 4 (DN 65 to DN 100) Fittings: Stainless steel grip ring and EPDM O-ring seal in each end.
5. Housing: Copper or bronze.
6. Press Ends: Un-pressed fitting identification feature to the fitting wall.
7. Sealing Element: EPDM.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP-5 Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A.Y. McDonald Mfg. Co.
   b. Capitol Manufacturing Company.
   c. Central Plastics Company.
   d. HART Industrial Unions, LLC.
   e. Jomar Valve.
   f. Matco-Norca.
   g. WATTS.
   h. Wilkins.
   i. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C.
4. End Connections: Solder-joint, or press-connect joint, copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. WATTS.
   e. Wilkins.
   f. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C.
5. End Connections: Solder-joint, threaded, or press-connect, copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elster Perfection Corporation.
   b. Grinnell Mechanical Products.
   c. Matco-Norca.

d. Precision Plumbing Products.
e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C)
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 – EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve and pressure gage inside the building at each domestic water-service entrance.

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install sleeves for piping penetrations of walls, ceilings, and floors.

O. Install sleeve seals for piping penetrations of concrete walls and slabs.

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Press-Connect Joints for Copper Tubing: Join copper tube and pressure-connect fittings with tools recommended by fitting manufacturer.

1. Mark proper insertion depth prior to making press connection.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100) Use dielectric flange kits.

D. Dielectric Fittings for NPS 2-1/2 (DN 65) and Larger: Use dielectric flange kits.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 4 (DN 80 to DN 100): 10 feet (3 m) with 1/2-inch (13-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.6 IDENTIFICATION

A. Identify system piping and components.

B. Label pressure piping with system operating pressure.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in “Piping Tests” Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Repeat procedures if biological examination shows contamination.
   e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be the following:

1. Soft copper tube, ASTM B88, Type K (ASTM B88M, Type A) wrought-copper, solder-joint fittings; and brazed copper press-connect fittings; and press-connect joints.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller shall be the following:

1. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B; cast or wrought copper, solder-joint fittings; and [brazed] [soldered] joints.
2. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper press-connect fittings; and press-connect joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be the following:

1. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B; cast or wrought copper, solder-joint fittings; and [brazed] [soldered] joints.
2. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper press-connect fittings; and press-connect joints.

3.11 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves.
2. Throttling Duty: Use ball valves.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119

PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes plumbing specialties for the following:

1. Water distribution systems.
2. Soil, waste, and vent systems.
3. Storm drainage systems.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Water Distribution Piping: 125 psig.
2. Soil, Waste, and Vent Piping: 10-foot head of water.
3. Storm Drainage Piping: 10-foot head of water.
4. Force-Main Piping: 100 psig.

1.4 SUBMITTALS

A. Product Data: For each plumbing specialty indicated. Include rated capacities of selected equipment and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components, and piping and wiring connections for the following plumbing specialty products:

1. Backflow preventers.
2. Balancing valves.
3. Thermostatic water mixing valves.
4. Water hammer arresters.
5. Drain trap seals.
6. Hose bibbs and hydrants.
7. Outlet boxes.
8. Cleanouts.
9. Floor drains.
10. Vent terminals, and roof flashing assemblies.
11. Roof drains.

B. Reports: Specified in "Field Quality Control" Article.

C. Maintenance Data: For specialties to include in the maintenance manuals. Include the following:

1. Thermostatic water mixing valves.
2. Hydrants.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, dimensional requirements, and characteristics of plumbing specialties and are based on the specific types and models indicated. Other manufacturers' products with equal performance characteristics may be considered.

B. Provide listing/approval stamp, label, or other marking on plumbing specialties made to specified standards.

C. Listing and Labeling: Provide electrically operated plumbing specialties specified in this Section that are listed and labeled.

1. Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.

D. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

E. Comply with NFPA 70, "National Electrical Code," for electrical components.

F. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic potable-water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Calibrated Balancing Valves:
   a. Armstrong Pumps, Inc.
   b. ITT Fluid Technology Corp.; ITT Bell & Gossett Div.
   c. Taco, Inc.
   d. Watts Industries, Inc.; Water Products Div.
2. Thermostatic Water Mixing Valves:
   a. Appollo/Conbraco Industries, Inc.
   b. Bradley Corp.
   c. Lawler Manufacturing Co., Inc.
   d. Leonard Valve Co.
   e. Mark Controls Corp.; Powers Process Controls.
   f. Symmons Industries, Inc.
3. Outlet Boxes:
   a. Acorn Engineering Co.
   b. Guy Gray Manufacturing Co., Inc.
   c. IPS Corp.
   d. LSP-Specialty Products Co.
   e. Oatey Co.
   f. Plastic Oddities, Inc.
   g. Symmons Industries, Inc.
4. Wall Hydrants:
   a. Josam Co.
   b. Smith: Jay R. Smith Mfg. Co.
   c. Tyler Pipe; Wade Div.
   d. Watts Industries, Inc.; Water Products Div.
   e. Woodford Manufacturing Co.
   f. Zurn Industries, Inc.; Hydromechanics Div.
5. Roof Hydrants:
   a. Mapa MPH-24-FP
   b. J.R. Smith 5903
   c. Woodford SRH-MS

6. Water Hammer Arresters:
   a. Josam Co.
   b. Smith: Jay R. Smith Mfg. Co.
   c. Tyler Pipe; Wade Div.
   d. Watts Industries, Inc.;
   e. Zurn Industries, Inc.; Hydromechanics Div.
7. Drain Trap Seals:
   a. J. R. Smith; Quad Close
   b. Proset Trap Guard
   c. Rectorseal Sure Seal
   d. IPS Green Drain
8. Cleanouts:
   a. Josam Co.
   b. Mifab
   c. Smith: Jay R. Smith Mfg. Co.
   d. Tyler Pipe, Wade Div.
   e. Watts
   f. Zurn Industries, Inc., Hydromechanics Div.
9. Floor Drains:
   a. Josam Co.
   b. Mifab
   c. Smith: Jay R. Smith Mfg. Co.
   d. Tyler Pipe, Wade Div.
   e. Watts
   f. Zurn Industries, Inc., Hydromechanics Div.
10. Roof Drains:
    a. Josam Co.
    b. Mifab
    c. Smith: Jay R. Smith Mfg. Co.
    d. Tyler Pipe, Wade Div.
    e. Watts
    f. Zurn Industries, Inc., Hydromechanics Div.

2.2 BALANCING VALVES

A. Calibrated Balancing Valves: Adjustable, with 2 readout ports and memory setting indicator. Include manufacturer's standard hoses, fittings, valves, differential pressure meter, and carrying case.

1. 2-Inch NPS and Smaller: Bronze body with brass ball, adjustment knob, calibrated nameplate, and threaded or solder-joint ends.

2.3 THERMOSTATIC WATER MIXING VALVES

A. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and capacity at pressure loss as indicated.

1. Bimetal Thermostat, Operation and Pressure Rating: 125 psig minimum.
2. Liquid-Filled Motor, Operation and Pressure Rating: 100 psig minimum.

B. Thermostatic Water Mixing Valves: Unit, with the following:

1. Piping of sizes and in arrangement indicated. Include valves and unions.
2. Piping Component Finish: Rough brass.
3. Cabinet: Steel box with steel hinged door and white enameled finish.
4. Cabinet Mounting: Recessed.
5. Cabinet Mounting: Surface.
6. Thermometer: Manufacturer's standard.

2.4 OUTLET BOXES

A. General: Recessed-mounting outlet boxes with fittings complying with ASME A112.18.1M. Include box with faceplate, services indicated for equipment connections, and wood-blocking reinforcement.

B. Ice Maker Outlet Boxes: With hose connection and the following:

1. Box and Faceplate: Plastic.
2. Shutoff Fitting: Supply stop.
3. Supply Fitting: 1/4-inch NPS copper, water tubing.

C. Condensate Drain Box: Stainless steel box and face plate; hinged and lockable door; 2” drain fitting; 1” dam and 1-1/2” hole in top of box. See drawing detail for piping requirements.

D. Reinforcement: 2-by-4-inch- or 2-by-6-inch-, fire-retardant-treated-wood blocking between studs.

2.5 HYDRANTS

A. Wall Hydrants: ASME A112.21.3M or ASSE 1019, non-freeze, automatic draining, anti-backflow type, key operation, with 3/4- or 1-inch NPS threaded or solder-joint inlet, and ASME B1.20.7 garden-hose threads on outlet. Include operating key for each hydrant.

1. Type: Recessed.
2. Finish: Nickel bronze.

B. Roof Hydrants: ASSE 1057, non-freeze, automatic draining with 3/4-inch inlet and garden hose outlet. Include roof flashing and under-deck flange.

2.6 DRAIN TRAP SEALS

A. Drain Trap Seals: Fitting installations in drain body outlets to block sewer gases.

1. ASSE 1072 compliant.
2. HDPE or DBS plastic frame with silicon or EDPM sealing gasket.

2.7 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arrestors: Provide water hammer arrestors where indicated on drawings. Unit shall be constructed of stainless-steel bellows arranged in a pressurized expansion chamber and shall have lifetime warranty. Units shall have P.D.I symbol that relates to fixture unit rating.

B. Hose Bibbs: Bronze body, with renewable composition disc, 1/2- or 3/4-inch NPS threaded or solder-joint inlet. Provide ASME B1.20.7 garden-hose threads on outlet and integral or field-installed, nonremovable, drainable, hose-connection vacuum breaker.

1. Finish: Rough brass.
2. Operation: Operating key (handle) type. Include operating key.

C. Roof Flashing Assemblies: Manufactured assembly made of 4-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.

D. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section of length to provide depth indicated; and where indicated, increaser fitting of size indicated, joined with ASTM C 564 rubber gaskets. Size P-trap as indicated.

E. Vent Terminals: Commercially manufactured, shop-fabricated or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing, as indicated.

2.8 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4 lb/sq. ft. or 0.0625-inch thickness.
2. Vent Pipe Flashing: 3 lb/sq. ft. or 0.0469-inch thickness.
3. Burning: 6 lb/sq. ft. or 0.0937-inch thickness.

B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Solder: ASTM B 32, lead-free alloy.

F. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 CLEANOUT

A. Cleanout: Where plumbing specialties of this designation are indicated, provide products complying with the following and with the Fixture Schedule on the drawings.

1. Applicable Standard: ASME A112.36.2M. ASME A112.3.1.

2.10 FLOOR DRAIN

A. Floor Drain: Where plumbing specialties of this designation are indicated, provide products complying with the following and with Fixture Schedule on drawings:

1. Applicable Standard: ASME A112.21.1M. ASME A112.21.1M floor drain with ASME A112.14.1 backwater valve. ASME A112.3.1.

2.11 ROOF-DRAIN

A. Roof Drain: Where plumbing specialties of this designation are indicated, provide products complying with the following and with the Fixture Schedule on Drawings:

1. Applicable Standard: ASME A112.21.2M. ASME A112.3.1.

PART 3 - EXECUTION

3.1 PLUMBING SPECIALTY INSTALLATION

A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.

B. Install hose bibbs with integral or field-installed vacuum breaker.

C. Install wall hydrants with integral or field-installed vacuum breaker.

D. Install drain trap seals in drain body outlets as noted.

E. Install cleanouts in aboveground piping and building drain piping as indicated, and where not indicated, according to the following:

1. Size same as drainage piping up to 4-inch NPS. Use 4-inch NPS for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping 3-inch NPS and smaller and 80 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

F. Install cleanout deck plates, of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.

G. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

H. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

I. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

J. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor or as indicated. Size outlets as indicated.

K. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed.

L. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

M. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

N. Position floor drains for easy access and maintenance.

O. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Size outlets as indicated.

P. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.

Q. Position roof drains for easy access and maintenance.

R. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

S. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.

T. Secure supplies to supports or substrate.

U. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated.

V. Install water-supply stop valves in accessible locations.

W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

X. Locate drainage piping as close as possible to bottom of floor slab supporting fixtures and drains.

Y. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

Z. Include blocking reinforcement for recessed and wall-mounting plumbing specialties.

AA. Anchor roof hydrants to roof deck. Anchor in accordance with manufacturer's instructions. Coordinate flashing with roofing installer.

3.2 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. Install piping connections between plumbing specialties and piping specified in other Division 22 sections.
2. Install piping connections indicated between appliances and equipment specified in other Sections; connect directly to plumbing piping systems.
3. Install piping connections indicated as indirect wastes from appliances and equipment specified in other Sections, to spill over receptors connected to plumbing piping systems.

B. Install hoses between plumbing specialties and appliances as required for connections.

C. Arrange for electric-power connections to plumbing specialties and devices that require power.

D. Supply Runouts to Plumbing Specialties: Install hot- and cold-water-supply piping of sizes indicated, but not smaller than required by authorities having jurisdiction.

E. Drainage Runouts to Plumbing Specialties: Install drainage and vent piping, with approved trap, of sizes indicated, but not smaller than required by authorities having jurisdiction.

3.3 FLASHING INSTALLATION

A. Fabricate flashing manufactured from single piece unless large pans, sumps, or other drainage shapes are required.

B. Burn joints of lead sheets where required.

C. Solder joints of copper sheets where required.

D. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

E. Set flashing on floors and roofs in solid coating of bituminous cement.

F. Secure flashing into sleeve and specialty clamping ring or device.

G. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.

H. Fabricate and install flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection if indicated.

3.4 FIELD QUALITY CONTROL

A. Test and adjust plumbing specialty controls and safeties. Replace damaged and malfunctioning controls and components.

3.5 COMMISSIONING

A. Before startup, perform the following checks:

1. System tests are complete.
2. Damaged and defective specialties and accessories have been replaced or repaired.
3. Clear space is provided for servicing specialties.

B. Before operating systems, perform the following steps:

1. Close drain valves, hydrants, and hose bibbs.
2. Open general-duty valves to fully open position.
3. Remove and clean strainers.
4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.

C. Startup Procedures: Follow manufacturer's written instructions.

D. Adjust operation and correct deficiencies discovered during commissioning.

3.6 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221119

SECTION 221123

WATER DISTRIBUTION PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of water distribution pumps and accessories for domestic hot water return systems:

1. In-line circulators.
2. Aquastats for control of pump operation.
3. Time clocks for control of pump operation.

1.3 PUMP PERFORMANCE REQUIREMENTS

A. Pump Pressure Ratings: At least equal to system maximum operating pressure at point where installed.

B. Selection Point: All pump design operating points shall be left of the maximum efficiency point on the pump curve. Pump inlet fluid velocity shall not exceed 12 feet per second.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data including certified performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories. Include startup instructions.

C. Wiring diagrams detailing wiring for power, signal, and control systems differentiating between manufacturer-installed wiring and field-installed wiring.

D. Product certificates signed by pump manufacturers certifying accuracies under specified operating conditions and compliance with specified requirements.

E. Maintenance data for each type of pump, aquastat and time clock specified to include in the Operating and Maintenance Manual.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following:

1. ASME B31.9 "Building Services Piping" for piping materials and installation.
2. UL 778 "Standard for Motor Operated Water Pumps" for construction requirements. Include UL listing and labeling.
3. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labeling.
4. NFPA 70 "National Electrical Code" for electrical components and installation.

B. Single-Source Responsibility: Obtain same type of pumps from a single manufacturer.

C. Single-Source Responsibility: Obtain same type of pumps from a single manufacturer with pumps, components, and accessories from a single source. Include responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

D. Design Criteria: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Design Professional. The burden of proof for equality of pumps is on the proposer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pumps in a clean, dry location.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, or other foreign matter.

D. Comply with pump manufacturer's rigging instructions for handling and supporting.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. In-Line Circulators:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Div., ITT Fluid Technology Corp.
   c. Grundfos Pumps Corp.
   d. Taco, Inc.
2. Aquastats:
   a. Honeywell
   b. Johnson
   c. Robert Shaw
   d. Barbar Colman
3. Time Clock:
   a. Honeywell
   b. Intermatic
   c. Taco

2.2 PUMPS, GENERAL

A. Water Distribution Pumps: Factory assembled and tested.

B. Capacities and Characteristics: As indicated.

C. Motors: NEMA MG 1; single, multiple, or variable speed with type of enclosure and electrical characteristics indicated. Include built-in thermal-overload protection and grease-lubricated ball bearings. Motors are non-overloading within full range of pump performance curves.

D. Finish: Manufacturer's standard paint applied to factory-assembled and -tested plumbing pump units before shipping.

E. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3 IN-LINE CIRCULATORS

A. General Description: Horizontal, in line, centrifugal, single stage, rated for 125-psig minimum working pressure and 225 deg F continuous water temperature.

B. In-Line Circulator: Leakproof, in-line, seal-less, volute-type pump. Include pump and motor assembled on a common shaft in a hermetically sealed unit, without stuffing boxes or mechanical seals. Lubricate sleeve bearing and cool motor by circulating pumped liquid through motor section. Isolate motor section from motor stator windings with a corrosion-resistant, nonmagnetic alloy liner.

1. Casing: Lead-free bronze or stainless steel; static O-ring seal to separate motor section from motor stator; and, flanged piping connections.
2. Impeller: Overhung, single-suction, closed or open nonmetallic impeller.
3. Shaft and Sleeve: Ceramic shaft with carbon-steel bearing sleeve.

2.4 GENERAL-DUTY VALVES

A. Refer to other Division 22 sections for general-duty gate, ball, butterfly, globe, and check valves.

2.5 AQUASTATS

A. General Description: Metal enclosure, strap-on mounting, visible point scale, external adjustment screw, 65F to 200F operating range.

2.6 TIME CLOCKS

A. Seven-day, programming-switch timer with synchronous-timing motor and 7-day dial; continuously charged, nickel-cadmium-battery-driven, 8-hour, power-failure carryover; multiple-switch trippers; minimum of 2 and maximum of 8 signals per day with 2 normally open and 2 normally closed output contacts.

B. Solid-state, programmable time control with 4 separate programs; 24-hour battery carryover; individual ON-OFF-AUTO switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections prior to pump installation.

3.2 INSTALLATION

A. Install pumps according to the manufacturer's written installation instructions.

B. Install pumps in locations indicated and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping so that weight of piping is not supported by pumps.

D. Secure aquastat to hot water return piping upstream of circulating pump.

E. Install time clock and aquastat.

3.3 CONNECTIONS

A. Connect piping to pumps as indicated. Install valves that are same size as piping connecting to pumps.

B. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

C. Install shutoff valve on suction side of in-line pumps and circulators.

D. Install check valve and throttling valve on discharge side of in-line pumps and circulators.

E. Install electrical connections for power, controls, and devices.

F. Coordinate and connect wiring of aquastats and time clocks for controls of circulator pump operation.

G. Electrical power and control wiring and connections are specified in Division 26 Sections.

3.4 FIELD QUALITY CONTROL

A. Check suction piping connections for tightness to avoid drawing air into pumps.

B. Pump Controls: Set aquastats and time clocks for automatic start and stop operation of pump.

3.5 COMMISSIONING

A. Final Checks Before Startup: Perform the following preventive maintenance operations and checks before startup:

1. Disconnect couplings and check motors for proper rotation. Rotation shall match direction of rotation marked on pump casing.
2. Check that pumps are free to rotate by hand. Pumps for handling hot liquids shall be free to rotate with pump hot and cold. Do not operate pump if bound or if it drags even slightly until cause of trouble is determined and corrected.
3. Check that pump controls are correct for required application.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power:

1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
2. Open the liquid supply valves if pumps are so fitted.
3. Open circulating line valves if pumps should not be operated against dead shutoff.
4. Start motors.
5. Open discharge valves slowly.
6. Check general mechanical operation of pumps and motors.
7. Close circulating piping valves once there is sufficient flow through pumps to prevent overheating.
8. Set aquastat operating temperature for 5ºF les than hot water supply temperature.
9. Set time clock operation as directed by Owner’s representative.

END OF SECTION 221123

SECTION 221316

DRAINAGE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes sanitary drainage and vent piping, and storm drainage piping inside building and to locations indicated.

1.3 DEFINITIONS

A. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewage from building.

B. Storm Drainage Piping: Building sewer piping outside building that conveys storm drainage from building.

C. Service Entrance Piping: Drainage piping at entry into building between outside building sewer piping and inside drainage piping.

D. Soil, Waste and Vent Piping: Piping inside building that conveys waste water and vapors from fixtures and equipment throughout the building.

E. Force-Main Piping: Drainage piping, under pressure.

F. The following are industry abbreviations for plastic and other piping materials:

1. EPDM: Ethylene-propylene-diene polymer, rubber.
2. PVC: Polyvinyl chloride.

G. Underground Piping: Piping located below slab or grade and to within 6-inches above slab or grade.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Soil, Waste, and Vent Systems: 10-foot head of water.
2. Sewerage Piping: 10-foot head of water.
3. Storm Drainage Systems: 10-foot head of water.
4. Sewage, Force-Main Piping Systems: 80 psig.

1.5 SUBMITTALS

A. Product Data: For each plumbing specialty indicated. Indicate materials, finishes, dimensions, and methods of assembly of components for the following plumbing specialty products:

1. Pipe and Fittings.
2. Pipe Couplings.

1.6 QUALITY ASSURANCE

A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.

B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic piping components. Include “NSF” marking for plastic drain and sewerage piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cast Iron Soil Piping:
   a. Charlotte Pipe and Foundry Co.
   b. Tyler Pipe & Couplings

2.2 PIPES AND TUBES

A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.

B. Hubless, Cast-Iron Soil Pipe: ASTM A 888 or CISPI 301.

C. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.

D. PVC Plastic Pipe: ASTM D 2665, Schedule 40.

2.3 PIPE AND TUBE FITTING

A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.

B. Threaded-Fitting, End Connections: ASME B1.20.1.

C. Hubless, Cast-Iron, Soil-Pipe Fittings: CISPI 301.

D. Copper, Solder-Joint Drainage Fittings: ASME B16.23 cast copper or ASME B16.29 wrought copper.

E. Copper, Solder-Joint Pressure Fittings: ASME B16.18 cast-copper alloy or ASME B16.22 wrought copper. Furnish wrought-copper fittings if indicated.

F. Copper, Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.

G. Bronze Flanges: ASME B16.24, Class 150, bronze, with solder-joint end.

H. Copper Unions: ASME B16.18, cast-copper-alloy, hexagonal-stock body with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends.

I. Cast-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.

J. Cast-Iron, Threaded Drainage Fittings: ASME B16.12, galvanized, recessed, drainage pattern.

K. Cast-Iron, Threaded Flanges: ASME B16.1, Class 125.

L. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311 drain, waste, and vent pipe paterns.

2.4 JOINING MATERIALS

A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.

B. Refer to Division 22 Section for commonly used joining materials.

C. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; made by piping system manufacturer for joining system piping.

D. Solder: ASTM B 32, Alloy Sn95, Sn94, or E; lead free.

E. Hubless, Cast-Iron, Soil-Piping Couplings: Assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve or gasket with integral, center pipe stop. Include the following:

1. Heavy Duty, Stainless-Steel Couplings: Shall comply with ASTM C 1540 with ASTM C 564, Type 304, stainless-steel corrugated shield; and stainless-steel bands. Include sealing sleeve.
   a. Clamp Width: 3 inches wide with 4 clamps, for piping 12 through 4-inch NPS.
   b. Clamp Width: 4 inches wide with 6 clamps, for piping 6 through 10-inch width.

F. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.5 VALVES

A. Refer to other Division 22 sections for general-duty valves. Use valves specified for "Domestic Water Systems" applications.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Aboveground, Soil, Waste, and Vent Piping: Use the following:

1. 1-1/4- and 1-1/2-Inch NPS: Hard copper drainage tube; copper, solder-joint drainage fittings; and soldered joints.
2. 1-1/2 Inch through 12-Inch NPS: Hubless, cast iron soil pipe; hubless, cast-iron, soil-pipe fittings; and the following heavy duty hubless, cast-iron, soil-piping couplings.
   a. Couplings: Heavy Duty, Type 304, stainless steel.

D. Underground, Soil, Waste, and Vent Piping: Use the following:

1. 12-Inch NPS and smaller: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

E. Aboveground, Storm Drainage Piping: Use the following:

1. 2- to 12-Inch NPS: Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:
   a. Couplings: Heavy-duty, Type 304, stainless steel.

F. Underground, Storm Drainage Piping: Use the following:

1. 12-Inch NPS and smaller: PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

G. Force Mains: Use the following:

1. 2- to 6-Inch NPS: Hard copper water tube, Type L; copper, solder-joint pressure fittings; and soldered joints.

3.2 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use gate, ball, or butterfly valves.

3.3 PIPING INSTALLATION, GENERAL

A. Refer to Division 22 Section for basic piping installation.

3.4 SERVICE ENTRANCE PIPING INSTALLATION

A. Extend building sanitary drain piping and connect to sanitary sewer piping in sizes and locations indicated for service entrances into building. Install cleanout and extension to grade at connections of building sanitary drains with building sanitary sewers.

B. Extend building storm drain piping and connect to storm sewer piping in sizes and locations indicated for service entrances into building. Install cleanout and extension to grade at connections of building storm drains and building storm sewers.

C. Extend building sanitary drain, force-main piping and connect to sanitary sewer piping in size and location indicated for service entrance into building. Install cleanout, fitting with closure plug or equivalent, inside building.

D. Install sleeve at each service entrance pipe penetration through foundation wall. Refer to Division 22 Section for sleeves.

E. Install wall penetration system at each service entrance pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section for wall penetration systems.

3.5 DRAINAGE AND VENT PIPING INSTALLATION

A. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

B. Make changes in direction for drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back-to-back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not make change in direction of flow greater than 90 degrees. Use proper size of standard increasers and reducers if different sizes of piping are connected. Reducing size of drainage piping in direction of flow is prohibited.

C. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

D. Install drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Sanitary Building Drain: 2 percent downward in direction of flow for piping 2-inch NPS and smaller; 1 percent downward in direction of flow for piping 3-inch NPS and larger.

2. Storm Building Drain: 1 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

E. Install force mains at elevations indicated.

F. Sleeves are not required for cast-iron soil piping passing through concrete slab on grade if slab is without membrane waterproofing.

G. Install PVC plastic drainage piping according to ASTM D 2665.

H. Install underground PVC plastic drainage piping according to ASTM D 2321.

3.6 JOINT CONSTRUCTION

A. Refer to other Division 22 sections for basic piping joint construction.

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Hubless Joints: Make with rubber gasket and sleeve or clamp.

C. PVC Piping Joints: Join drainage piping according to ASTM D 2665.

D. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling during joining of plastic pipe and fittings.

3.7 VALVE INSTALLATION

A. Shutoff Valves: Install shutoff valve on each pump discharge and where indicated. Use gate or ball valves for piping 2-inch NPS and smaller.

B. Check Valves: Install swing check valve on each pump discharge, downstream from shutoff valve.

3.8 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Riser clamps, MSS Type 8 or Type 42, for vertical runs.
2. Adjustable steel clevis hangers, MSS Type 1, for individual, horizontal runs.

B. Install supports according to Division 22 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. 1-1/4-Inch NPS: Maximum horizontal spacing, 72 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
2. 1-1/2 and 2-Inch NPS: Maximum horizontal spacing, 96 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.

F. Install hangers for cast-iron soil piping with the following maximum spacing and minimum rod diameters:

1. 1-1/2- and 2-Inch NPS: Maximum horizontal spacing, 60 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
2. 3-Inch NPS: Maximum horizontal spacing, 60 inches with 1/2-inch minimum rod diameter; maximum vertical spacing, 15 feet.

3. 4- and 5-Inch NPS: Maximum horizontal spacing, 60 inches with 5/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
4. 6-Inch NPS: Maximum horizontal spacing, 60 inches with 3/4-inch minimum rod diameter; maximum vertical spacing, 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

A. Connect service entrance piping to exterior sewerage and drainage piping. Use transition fitting to join dissimilar piping materials.

B. Connect drainage piping to service entrance piping, and extend to and connect to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
3. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections 2-1/2-inch NPS and larger.

C. Connect force-main piping to service entrance piping, and extend to and connect to the following:

1. Sump Pumps: Connect force-main piping to sump-pump discharge.

3.10 ACCESSORIES INSTALLATION:

A. Install accessories according to manufacturer’s written instructions and as indicated.

3.11 FIELD QUALITY CONTROL

A. Inspect drainage and vent piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedure, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

3. Roughing-In Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10 feet of head. Water level must not drop from 15 minutes before inspection starts through completion of inspection. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gas tight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects using new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedure, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects using new materials and retest piping or portion thereof until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.12 CLEANING AND PROTECTING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

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SECTION 221416

NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes piping, specialties, and accessories for natural gas systems within building and to gas meters.

1.3 DEFINITIONS

A. Low-Pressure Natural Gas Piping: Operating pressure of 0.5 psig or less.

B. Medium-Pressure Natural Gas Piping: Operating pressure greater than 0.5 psig, but not greater than 2 psig.

C. High-Pressure Natural Gas Piping: Operating pressure greater than 2 psig, but not greater than 5 psig.

D. Gas Service: Pipe from gas main or other source to gas point of delivery for building being served. Piping includes gas service piping, gas valve, service pressure regulator, meter bar or meter support, and gas meter.

E. Gas Delivery Point: Gas meter or service pressure regulator outlet, or gas service valve if gas meter is not provided.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Working-Pressure Ratings: Except where otherwise indicated, minimum pressure requirements are as follows:

1. Low-Pressure Natural Gas Piping: 2 psig.
2. Medium-Pressure Natural Gas Piping: 10 psig.
3. High-Pressure Natural Gas Piping: 20 psig.

B. Approximate values of natural gas supplied for these systems are as follows:

1. Heating Value: 1000 Btu/cu. ft.
2. Specific Gravity: 0.6.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each type of natural gas specialty and special-duty valve. Include pressure rating, rated capacity, and settings of selected models.

C. Coordination Drawings for natural gas piping, including required clearances and relationship to other services for same work areas.

D. Test reports specified in "Field Quality Control" Article in Part 3.

E. Maintenance data for natural gas specialties and special-duty valves to include in the operation and maintenance manual.

1.6 QUALITY ASSURANCE

A. Comply with International Fuel Gas Code and NFPA 54, "National Fuel Gas Code," for gas piping materials and components; installations; and inspecting, testing, and purging.

B. Comply with NFPA 70, "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

C. Provide listing/approval stamp, label, or other marking on equipment made to specified standards.

D. Listing and Labeling: Provide equipment and accessories specified in this Section that are listed and labeled.

1. Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.

E. Product Options: Drawings indicate size, profiles, connections, dimensional requirements, and characteristics of natural gas piping equipment, specialties, and accessories and are based on specific types and models indicated. Other manufacturers' equipment and components with equal performance characteristics may be considered.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.8 SEQUENCING AND SCHEDULING

A. Notification of Interruption of Service: Notify each affected user when gas supply will be turned off.

B. Work Interruptions: Leave gas piping systems in safe condition when interruptions in work occur during repairs or alterations to existing gas piping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Gas Ball Valves, 2-Inch NPS and Smaller:
   a. Jomar Valve
   b. Legend Valve
   c. Maxitrol Co.
   d. McDonald: A.Y. McDonald Mfg. Co.
   e. Milwaukee Valve Co., Inc.
   f. National Meter.
2. Gas Valves, 2-1/2-Inch NPS and Larger:
   a. Mueller Steam Specialty Div.
   b. Milliken Valve Co., Inc.
   c. Nordstrom Valves, Inc.
   d. Olson Technologies, Inc.; Homestead Valve Div.
3. Gas Pressure Regulators:
   a. American Meter Co.
   b. Fisher Controls International, Inc.
   c. Maxitrol Co.
   d. Pietro Fiorentini
   e. Richards Industries, Inc.; Jordan Valve Div.

2.2 PIPES AND TUBES

A. Steel Pipe: ASTM A 53; Type E, electric resistance welded or Type S, seamless; Grade B; Schedule 40; black. All exposed piping shall be brushed, primed and painted.

2.3 PIPE AND TUBE FITTINGS

A. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends conforming to ASME B1.20.1.

B. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends conforming to ASME B1.20.1.

C. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250.

D. Steel Fittings: ASME B16.9, wrought steel, butt-welding type; and ASME B16.11, forged steel.

E. Steel Flanges and Flanged Fittings: ASME B16.5.

F. Transition Fittings: Type, material, and end connections to match piping being joined.

2.4 JOINING MATERIALS

A. Common Joining Materials: Refer to Division 22 Sections for joining materials not included in this Section.

B. Joint Compound and Tape: Suitable for natural gas.

C. Gasket Material: Thickness, material, and type suitable for natural gas.

2.5 VALVES

A. Gas Valves, 3-Inch NPS and Smaller: 250 psig WOG minimum, equivalent to ASME B16.33, bronze body with chrome plated brass ball and polytetrafluoroethylene (PTFE) seats and seals Include lever handle or flat head and threaded ends conforming to ASME B1.20.1.

B. Gas Valves, 4-Inch NPS and Larger: MSS SP-78, Class 125 or Class 175 WOG, nonlubricated-plug type with polytetrafluoroethylene (PTFE) lining or sleeve, semisteel body, wrench operated, with flanged ends.

2.6 PIPING SPECIALTIES

A. Gas Pressure Regulators: ANSI Z21.18, single-stage, steel-jacketed, corrosion-resistant pressure regulators. Include atmospheric vent, elevation compensator, with threaded ends conforming to ASME B1.20.1 for 2-inch NPS and smaller and flanged ends for 2-1/2-inch NPS and larger. Regulator pressure ratings, inlet and outlet pressures, and flow volume in cubic feet per hour of natural gas at specific gravity are as indicated.

1. Service Pressure Regulators: Inlet pressure rating not less than natural gas distribution system service pressure.
2. Line Gas Pressure Regulators: Inlet pressure rating not less than system pressure.
3. Appliance Gas Pressure Regulators: Inlet pressure rating not less than system pressure, with capacity and pressure setting matching appliance.
4. Gas Pressure Regulator Vents: Factory- or field-installed corrosion-resistant screen in opening when not connected to vent piping.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close equipment shutoff valves before turning off gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

B. Comply with NFPA 54 Paragraph "Prevention of Accidental Ignition."

3.2 SERVICE ENTRANCE PIPING

A. Extend natural gas piping and connect to gas distribution system (gas service) piping in location and size indicated for gas service entrance to building.

B. Install shutoff valve, downstream from gas meter, outside building at gas service entrance.

3.3 GAS METER

A. Gas distribution system piping, service pressure regulator and gas meter will be provided by gas utility under this section. All fees for meter installation and connection shall be borne under this section. Coordinate revisions to gas pressure and volume requirements of gas meter with local utility.

3.4 PIPING APPLICATIONS

A. General: Flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating may be used in applications below, except where otherwise indicated.

B. Low-Pressure, 0.5 psig or Less, Natural Gas Systems: Use the following:

1. Gas distribution system piping, service pressure regulator, and gas meter to be provided and installed by gas utility under this section. All fees and costs for all materials and labor shall be borne by the contractor for the complete natural gas service system including (but not limited to) gas meter, gas entrance and distribution system piping and gas service pressure regulator.
2. 2-Inch NPS and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
3. 2-1/2 Inch NPS and Larger: Steel pipe, butt-welding fittings, and welded joints.

C. Medium-Pressure, 0.5 to 2 psig, Natural Gas Systems: Use the following:

1. 1-Inch NPS and Smaller: Steel pipe, butt-welding fittings, and welded joints.
2. 1-1/4-Inch NPS and Larger: Steel pipe, butt-welding fittings, and welded joints.

D. High-Pressure, above 2 to 5 psig, Natural Gas Systems: Steel pipe, butt-welding fittings, and welded joints.

3.5 VALVE APPLICATIONS

A. Use gas valves of sizes indicated for gas service piping, meters, mains, and where indicated.

3.6 PIPING INSTALLATIONS

A. Refer to Division 22 Sections for basic piping installation requirements.

B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves in such spaces.
2. In Floors: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in floors, subject to approval of authorities having jurisdiction. Surround piping cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.
4. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
   a. Exception: Tubing passing through partitions or walls.
5. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
6. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   a. Exception: Accessible above-ceiling space specified above.

C. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of gas meters. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, except where indicated to be exposed to view.

E. Install gas piping at uniform grade of 0.1 percent slope upward toward risers.

F. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

G. Connect branch piping from top or side of horizontal piping.

H. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

I. Install corrugated stainless-steel tube and fittings according to manufacturer's written instructions. Vent sleeved portion to exterior, turn vent down and screen outlet.

J. Install dielectric fittings (unions and flanges) with ferrous and brass or bronze end connections, separated by insulating material, where piping of dissimilar metals is joined.

K. Install dielectric fittings (unions and flanges) with 2 ferrous end connections, separated by insulating material, at outlet from gas meter and, where indicated, for ferrous piping.

L. Install flanges on valves, specialties, and equipment having 2-1/2-inch NPS and larger connections.

M. Anchor piping to ensure proper direction of piping expansion and contraction. Install expansion joints, expansion loops, and pipe guides as indicated.

N. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

3.7 JOINT CONSTRUCTION

A. Refer to Division 22 Sections for basic piping joint construction.

B. Use materials suitable for natural gas service.

3.8 VALVE INSTALLATION

A. Install valves in accessible locations, protected from damage.

B. Tag valves with metal tag indicating piping supplied. Attach tag to valve with metal chain.

C. Install gas valve upstream from each gas pressure regulator. Where 2 gas pressure regulators are installed in series, valve is not required at second regulator.

D. Install pressure relief or pressure-limiting devices so they can be readily operated to determine if valve is free; test to determine pressure at which they will operate; and examine for leakage when in closed position.

3.9 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Sections for pipe hanger and support devices.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. 1/2-Inch NPS: Maximum span, 72 inches; minimum rod size, 3/8 inch.
2. 3/4- and 1-Inch NPS: Maximum span, 96 inches; minimum rod size, 3/8 inch.
3. 1-1/4-Inch NPS: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. 1-1/2- and 2-Inch NPS: Maximum span, 108 inches; minimum rod size, 3/8 inch.
5. 2-1/2- to 3-1/2-Inch NPS: Maximum span, 10 feet; minimum rod size, 1/2 inch.
6. 4-Inch NPS and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

C. Support vertical pipe and tube at each floor.

3.10 CONNECTIONS

A. Install gas piping next to equipment and appliances using gas to allow service and maintenance.

B. Connect gas piping to equipment and appliances using gas with shutoff valves and unions. Install gas valve upstream from and within 72 inches of each appliance using gas. Install union or flanged connection downstream from valve. Include flexible connectors when indicated.

C. Sediment Traps: Install tee fitting with capped nipple in bottom forming drip, as close as practical to inlet for appliance using gas.

D. Electrical Connections: Wiring is specified in Division 26 Sections.

3.11 ELECTRICAL BONDING AND GROUNDING

A. Install aboveground portions of natural gas piping systems that are upstream from equipment shutoff valves, electrically continuous, and bonded to grounding electrode according to NFPA 70.

B. Do not use gas piping as grounding electrode.

3.12 PAINTING AND PIPE IDENTIFICATION

A. Exterior Applications:

1. Paint all exposed steel surfaces of piping and supports with one coat of primer and two coats of yellow enamel.

B. Label piping. Include labels to indicate pipe pressure on medium and high pressure pipe supplies.

3.13 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to "Gas Piping Inspection, Testing, and Purging" in NFPA 54 and International Fuel Gas Code.

B. Test piping for minimum of two hours. Test pressures shall be equal to twice the minimum working pressure ratings shown in section 221416, paragraph 1.4. A.

C. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

D. Report test results promptly and in writing to the Design Professional and authorities having jurisdiction.

E. Verify capacities and pressure ratings of gas meters, regulators, valves, and specialties.

F. Verify correct pressure settings for pressure regulators.

G. Verify that specified piping tests are complete.

3.14 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 221416

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SECTION 222023

UNDERGROUND NATURAL GAS DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This section covers the exterior gas distribution system and includes piping, unions, installation, and testing.

1.3 REFERENCE STANDARDS

A. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. International Fuel Gas Code.
2. NFPA 54, National Fuel Gas Code.
3. ASTM D2513, Standard Specification for Thermoplastic Gas Pipe, Tubing and Fittings.
4. ASTM D2774, Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
5. ASTM F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

1.4 QUALITY ASSURANCE

A. All materials, equipment and work shall meet all applicable federal, state and local requirements and conform to codes and ordinances of authorities having jurisdiction.

B. Valves: Manufacturer’s name, size, standards compliance and pressure rating clearly marked on outside of valve body.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.

D. Installer Qualifications: Company specializing in performing the Work of this Section with minimum three (3) years documented experience. Installation of natural gas systems shall be performed by individuals licensed as a Journeyman or Master Plumber by the appropriate state agency. All installation shall be supervised by a licensed Master Plumber. All testing shall be performed by a licensed Journeyman or Master Plumber.

1.5 SUBMITTALS

A. Product Data:

1. Provide manufacturer's product data and ratings on pipe materials, pipe fittings, and accessories.
2. Transition riser.
3. Warning tape.
4. Tracer wire.

B. Record Documents:

1. Submit test reports and inspection certification for all natural gas systems installed under this Contract.
2. Submit record drawings showing installed locations of underground piping, valves and regulators. Distances shall be measured from permanent above ground objects.
3. Provide full written description of manufacturer's warranty.

C. Operation and Maintenance Data:

1. Include installation instructions, spare parts lists, exploded assembly views manufacturer's recommended maintenance.

1.6 DELIVERY, STORAGE and HANDLING

A. Store valves on site in shipping containers with labeling in place, inspect for damage and store with a minimum of handling. Store plastic piping under cover out of direct sunlight. Do not store materials directly on the ground.

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

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

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work and isolating parts of completed system.

1.7 EXTRA MATERIALS

A. Provide one (1) plug valve wrench for every ten (10) plug valves.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Pipe joint compound shall be lead-free, non-toxic, non-hardening, insoluble in the presence of natural gas and compliant with ANSI/NSF 61 and Federal Specification TT-S-1732. Temperature service range of -15 degrees F to +400 degrees F.

2.02 PIPING

A. Buried Piping Outside of Building:

1. Polyethylene, medium density, SDR-11, ASTM D2513 pipe and fittings with heat fusion socket joints.
2. Polyethylene pipe and fitting materials shall be compatible and by same manufacturer to ensure uniform melting and a proper bond. Fabricated fittings shall not be used.

B. Transition riser: MDPE fused coating on steel pipe for connection to above ground building distribution piping. Underground horizontal metallic portion of riser shall be at least 24-inches in length before connecting to the plastic service pipe. An approved transition fitting or adaptor meeting design pressure rating and plastic pipe manufacturers recommendations shall be used where the plastic joins the metallic riser.

2.03 UNDERGROUND WARNING TAPE AND TRACER WIRE

A. Warning Tape: Minimum 3-inch-wide polyethylene detectable type marking tape. The tape shall be resistant to alkalis, acids and other destructive agents found in soil and impregnated with metal so that it can be readily recognized after burial by standard locating equipment.

1. Lamination bond of one (1) layer of Minimum 0.35 mils thick aluminum foil between two (2) layers of minimum 4.3 mils thick inert plastic film.
2. Minimum tensile strength: 63 LBS per 3 IN width.
3. Minimum elongation: 500 percent.
4. Provide continuous yellow with black letter printed message repeated every 16 to 36 inches warning of pipe buried below (e.g.: "CAUTION GAS LINE BURIED BELOW").

B. Tracer Wire: #16-gauge awg copper clad steel conducer with 30-mil. HDPE insulation rated for 30-volts and direct burial.

2.05 UNIONS

A. Unions in 2 inches and smaller in ferrous lines shall be right and left hand nipple/coupling assembly, or ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends, 2-1/2 inches and larger shall be ground flange unions. Companion flanges on lines at various items of equipment, machines and pieces of apparatus may serve as unions to permit disconnection of piping.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.

2.06 FLANGES

A. All 150 lb. and 300 lb. ANSI flanges shall be domestically manufactured, weld neck forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All thread rods will not be acceptable for flange bolts. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi. Flat-faced flanges shall be required to match flanges on pumps, check valves, strainers, etc. Only one manufacturer of weld flanges will be approved for each project.

B. All flanges shall be gasketed. Contractor shall place gasket between flanges of flanged joints. Gaskets shall fit within the bolt circle on raised face flanges and shall be full face on flat face flanges. Gaskets shall be cut from 1/16-inch thick, non-metallic, non-asbestos gasket material suitable for operating temperatures from -150 degrees F to +75 degrees F.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe ends and remove cutting burrs.

B. Remove dirt on inside and outside of piping, before assembly.

3.02 EQUIPMENT CONNECTIONS

A. Tapping of gas utility main shall be performed by local gas utility. Coordinate tie location. Contractor shall pay all costs.

B. Coordinate location of utility-provided gas meter. Install gas meter.

C. Provide specified connections, shutoff valves, regulators and unions at each gas meter and building.

D. Provide and install union type connections at all equipment to permit removal of service piping.

E. Rigid metallic pipe and fittings shall be used at service connections to all stationary equipment.

3.03 INSTALLATION

A. Provide transition riser at connection between buried plastic gas service piping and above grade piping in accordance with the gas code. Polyethylene piping shall not be installed above ground.

B. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

C. Provide support for and connections to natural gas service meter in accordance with requirements of the utility company.

D. All installation shall be in accordance with piping and equipment manufacturer’s published recommendations and ASTM D2774.

E. All excavation required shall be done in accordance with project specifications.

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

G. Bury all underground piping at least 3 feet below finished grade. Provide a continuous detectable warning tape and tracer wire on tamped backfill, 12-inches above all buried non-metallic gas lines.

H. Do not install gas piping in the same trench with other utilities. The minimum horizontal clearance between gas pipe and parallel utility pipe shall be 2 feet. Do not install gas pipe through catch basins, vaults, manholes or similar underground structures.

I. Install and support all polyethylene piping in accordance with manufacturer's recommendations. All heat fusion welds shall be performed by welders qualified to the manufacturer’s procedures.

J. All above ground gas piping shall be electrically continuous and bonded to electrical system ground conductor in accordance with NFPA 70.

K. Provide and install union type fittings at proper points to permit dismantling or removal of pipe. No unions will be required in welded lines except at equipment connections. Where union type fittings are necessary for piping dismantling purposes, right and left nipples and couplings shall be used. Flanges, ground-joint unions or approved flexible appliance connectors may be used at exposed fixture, appliance or equipment connections.

L. Valves, regulators, flanges, union type fittings and similar appurtenances shall be accessible for operation and servicing.

M. Route piping in orderly manner and maintain gradient. Install piping to conserve building space.

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

O. Close nipples, bushing and cross type fittings shall not be installed in any gas piping system.

P. Provide adequate clearance for access to and operation of all valves.

Q. Identify piping and valves in accordance with specifications.

3.04 TESTING

A. All natural-gas systems shall be inspected, tested, purged and placed into operation in accordance with NFPA 54 and as required herein.

B. All natural-gas piping systems shall be very carefully inspected, tested, purged and placed into operation by a licensed plumber.

C. All pneumatic tests shall be witnessed, recorded, and countersigned by the local inspector.

D. All necessary apparatus for conducting tests shall be furnished by the contractor and comply with the requirements of NFPA 54.

E. All new distribution piping and affected portions of existing systems connected to, shall be subjected to a pneumatic test pressure utilizing clean, dry air and must be demonstrated to be absolutely tight when subjected to the pressures and time durations listed herein. All equipment and components designed for operating pressures of less than the test pressure shall not be connected to the piping system during test.

1. Systems on which the normal operating pressure is less than 0.5 pounds per square inch gauge (psig), the test pressure shall be 5.0 psig and the time interval shall be 30 minutes.
2. Systems on which the normal operating pressure is 0.5 psig or greater, the test pressure shall be 2 times the normal operating pressure, and the time interval shall be two (2) hours.

F. After testing is complete, the entire gas system shall be purged with dry nitrogen to eliminate all air, debris, and moisture from the piping before natural gas is introduced into the system.

G. In all instances in which leaks are then found, they shall be eliminated in the manner designated by the Owner’s duly authorized representative. Testing operations shall be repeated until gas-piping systems are absolutely tight at the pneumatic test pressures indicated above.

END OF SECTION 222023

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SECTION 223300

ELECTRIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes electric water heaters and accessories.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, finishes and coatings, required clearances, methods of assembly of components, and piping and wiring connections.

C. Shop Drawings showing layout of each unit, including tanks, pumps, controls, related accessories, and piping.

D. Setting Drawings with templates and directions for installing foundation bolts, anchor bolts, and other anchorages.

E. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between factory-installed and field-installed wiring.

F. Field quality-control installation reports.

G. Maintenance data for water heaters to be included in operation and maintenance manuals. Include startup instructions.

1.4 QUALITY ASSURANCE

A. ASHRAE Standard: Comply with performance efficiencies prescribed in ASHRAE 90.1, "Energy Efficient Design of New Buildings."

B. NFPA Standard: Comply with NFPA 70, "National Electrical Code," for electrical components.

C. Listing and Labeling: Provide electrically operated water heaters, controls, and components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.

D. 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.

1.5 WARRANTY

A. General Warranty: The special warranty specified in this Article 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.

B. Warranty Period: 3 years after date of Material Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Commercial, Storage, Electric Water Heaters:
   a. Bradford White Corp.
   b. Lochinvar Corp.
   c. Rheem Mfg. Co.; Rheem Water Heater Div.
   d. Rheem Mfg. Co.; Ruud Water Heater Div.
   e. Smith: A.O. Smith Water Products Co.
   f. State Industries, Inc.
2. Expansion Tanks:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Expanflex, Inc.
   d. Smith: A.O. Smith; Aqua-Air Div.
   e. State Industries, Inc.

2.2 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.

1. 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 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 and Smaller: Threaded 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.

1. Exception: Omit relief valve for tankless water heater. Include pressure relief valve for installation in piping.

2.3 COMMERCIAL, STORAGE, ELECTRIC WATER HEATERS

A. Description: UL 1453, commercial, storage, electric water heater.

B. Storage Tank Construction: ASME labeled, steel with 150-psig working-pressure rating.

C. Storage Tank Construction: Steel with 150-psig working-pressure rating.

D. Heating Elements: Electric, screw-in or bolt-on, immersion type according to the following:

1. Up to 9-kW Input: 2 or 3 elements.
2. More than 9-kW Input: Elements arranged in multiples of 3.

E. Heating Elements: Electric, screw-in or bolt-on, immersion type arranged in multiples of 3.

F. Staging: Not exceeding 18 kW per step.

G. Temperature Control: Adjustable immersion thermostats.

H. Safety Control: Automatic, high-temperature-limit and low-water cutoffs.

I. Special Requirements: NSF 5 construction.

J. Vacuum Relief Valve: Comply with ASME PTC 25.3. Furnish for installation in piping.

2.4 EXPANSION TANKS

A. Description: Steel, pressured-rated tanks constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air per charge to minimum system-operating pressure at tank.

B. Construction: 150-psig working-pressure rating.

C. 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.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for water heaters and accessories. Refer to Division 22 Sections.

3.2 WATER HEATER INSTALLATION

A. General: Install water heaters on concrete bases. Set and connect units according to manufacturer's written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturer's recommended clearances. Install so that controls and devices are accessible for service.

B. Anchor water heaters and storage tanks to substrate.

C. Install temperature and pressure relief valves in top portion of storage water heater tanks and hot-water storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.

D. Install vacuum relief valves in cold-water-inlet piping.

E. Install water heater drain piping as direct waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Sections for drain valves.

F. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Division 22 Sections.

G. Install pressure gages on water heater piping when and as indicated. Pressure gages are specified in Division 22 Sections.

H. Install inlet and outlet piping manifolds for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through water heaters. Include throttling valves in outlet manifolds and thermometers in inlet and outlet manifolds.

I. Install piping adjacent to water heaters to allow service and maintenance.

J. Arrange for field-applied insulation on equipment and piping not furnished with factory-applied insulation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Connect hot- and cold-water piping to units with shutoff valves and unions. 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. Dielectric fittings are specified in Division 22 Sections.

B. Electrical Connections: Power wiring and disconnect switches are specified in Division 26 Sections. Arrange wiring to allow unit servicing.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.

1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Schedule training with Owner with at least 7 days' advance notice.

B. 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 for clear relief valve inlets, outlets, and drain piping.
5. Check operation of pumps and circulators.
6. Test operation of safety controls, relief valves, and devices.

C. Perform the following startup procedures:

1. Energize electric circuits.
2. Adjust operating controls.
3. Adjust hot-water-outlet temperature settings.

END OF SECTION 223300

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SECTION 224000

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes plumbing fixtures and trim, faucets, other fittings, and related components.

1.3 DEFINITIONS

A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, traps and waste pipes. Pipe fittings, tube fittings, and general-duty valves are included where indicated.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

C. Wiring diagrams from manufacturer for electrically operated units.

D. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category from one source and by a single manufacturer.

1. Exception: Where fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for this category.

B. Regulatory Requirements: Comply with requirements of 2010 ADA Standards for Accessible Design; regarding plumbing fixtures for physically handicapped people.

C. Energy Policy Act Requirements: Comply with requirements of Public Law 102-486, "Energy Policy Act," regarding water flow rate and water consumption of plumbing fixtures.

D. Listing and Labeling: Provide electrically operated fixtures and components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Product Options: Drawings indicate size, profiles, dimensional requirements, and characteristics of plumbing fixtures and are based on specific types and models indicated. Other manufacturers' fixtures with equal performance characteristics may be considered.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.

B. Store plumbing fixtures on elevated platforms in dry location.

1.7 PROJECT CONDITIONS

A. Field Measurements: Coordinate roughing-in and final fixture locations and verify that plumbing fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURE STANDARDS

A. Comply with applicable standards below and other requirements specified.

1. Electric Water Coolers: ARI 1010 and UL 399.
2. Emergency Equipment: ANSI Z358.1.
3. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
4. National Sanitation Foundation Construction: NSF 2.
5. Plastic Bathtubs: ANSI Z124.1, ANSI Z124.1a, and ANSI Z124.1b.
6. Plastic Shower Enclosures: ANSI Z124.2 and ANSI Z124.2a.
7. Slip-Resistant Bathing Surfaces: ASTM F 462.
8. Stainless-Steel Fixtures Other than Service Sinks: ASME A112.19.3M.
9. Vitreous-China Fixtures: ASME A112.19.2M.
10. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5 and ASSE 1037.

2.2 LAVATORY/SINK FAUCET STANDARDS

A. Comply with ASME A112.18.1M and other requirements specified for lavatory, sink, and similar-type-fixture faucet fittings. Include hot- and cold-water indicators; 2.0-gpm-maximum flow rate; and polished, chrome-plated finish; except where otherwise indicated. Coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
2. Faucet Hose: ASTM D 3901.
3. Hose-Connection Vacuum Breakers: ASSE 1011.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
6. Pipe Threads: ASME B1.20.1.
7. Sink Spray Hoses: ASTM D 3573.

2.3 MISCELLANEOUS FITTING STANDARDS

A. Comply with ASME A112.18.1M and other requirements specified for fittings, other than faucets. Include polished, chrome-plated finish, except where otherwise indicated. Coordinate fittings with other components and connectors.

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Automatic Flow Restrictors: ASSE 1028.
3. Brass and Copper, Supplies and Tubular Brass: ASME A112.18.1M.
4. Fixed Flow Restrictors: ASSE 1034.
5. Manual-Operation Flushometers: ASSE 1037.

2.4 MISCELLANEOUS COMPONENT STANDARDS

A. Comply with applicable standards below and other requirements specified for components for plumbing fixtures, equipment, and appliances.

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.21.1M.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Insulation Kits: CABO A117.1.

2.5 FITTINGS

A. Supplies:

1. Manufacturers and Models:
   a. Y. McDonald 2082 Series
   b. B&K 490 Series
   c. Brasscraft KTCS Series
   d. McGuire BV Series
   e. Watts 894 Series
   f. Zurn 8800 Series
2. Supply Inlet: Brass pipe or copper tube, size required for final connection.
3. Supply Stops: Chrome-plated brass, angle; chrome-plated brass ball; quarter-turn operation; ½" compression inlet and 3/8" o.d. compression outlet; same size as supply inlet and with outlet matching supply riser, chrome handle.
4. Supply Risers: 3/8" NPS flexible copper tube with knob end. Use chrome-plated tube for exposed applications.

B. Traps and Wastes:

1. Manufacturers:
   a. McGuire
   b. EBC
   c. Dearborne
   d. Watts
   e. Zurn
2. Traps: Tubular brass with 0.045" (17 ga.) Wall thickness, slip-joint inlet, cleanout, wall flange, escutcheons, and size to match equipment. Use chrome-plated tube for exposed applications.
3. Continuous Waste: Tubular brass, 0.045" (17 ga.) Wall thickness, with slip-joint inlet, and size to match equipment.
4. Indirect Waste: Hard copper DWV tube and solder joint fittings; size to match equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Include supports for plumbing fixtures according to the following:

1. Reinforcement: For floor-mounted lavatories and sinks that require securing to wall and recessed, box-mounted, electric water coolers.
2. Fabricate reinforcement from 2-by-4-inch or 2-by-6-inch fire-retardant-treated-wood blocking between studs or 1/4-by-6-inch steel plates attached to studs, in wall construction, to secure fixtures to wall. Include length that will extend beyond ends of fixture mounting bracket and attach to at least 2 studs.

B. Include fitting insulation kits for accessible fixtures according to the following:

1. Lavatories: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.
2. Sinks: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.
3. Fixtures with Offset Drain: Cover hot- and cold-water supplies, offset drain, trap, and waste to wall.
4. Other Fixtures: Cover exposed fittings below fixture.

3.3 PLUMBING FIXTURE INSTALLATION

A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.

B. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.

C. Install floor-mounted, floor-outlet water closets with fittings, waste outlet flanges and gasket seals.

D. Install toilet seats on water closets.

E. Install wall-hanging, back-outlet urinals with gasket seals.

F. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for handicapped people to reach.

G. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.

H. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.

I. Fasten recessed, wall-mounted fittings to reinforcement built into walls.

J. Fasten wall-mounted fittings to reinforcement built into walls.

K. Fasten counter-mounting plumbing fixtures to casework.

L. Secure supplies to supports or substrate within pipe space behind fixture.

M. Set mop basins in leveling bed of cement grout.

N. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.

O. Install water-supply stop valves in accessible locations.

P. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.

Q. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.

R. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

S. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.4 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. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Division 22 Sections.

B. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedules at the end of this Section for fitting sizes and connection requirements for each plumbing fixture.

C. Supply and Waste Connections to Equipment Specified in Other Sections: Connect equipment with supply inlets, supply stops, supply risers, and traps specified in this Section. Use fitting sizes required to match connected equipment. Connect fittings to plumbing piping.

D. Ground equipment.

1. Tighten electrical connectors and terminals 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.

E. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified in Division 26 Sections.

3.5 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at drinking fountains, electric water coolers, faucets, shower valves, and flushometer valves having controls, to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Include the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Owner.

3.8 WATER CLOSET SCHEDULE - FLUSH VALVE TYPE

A. Water Closet: Where plumbing fixtures of this designation are indicated, provide products complying with the following and with the Plumbing Fixture Schedule on the drawings:

1. Vitreous-China Water Closet:
   a. American Standard, Inc.
   b. Kohler Co.
   c. Sloan Valve Co.
   d. Zurn Plumbing Products
2. Flushometer Valve:
   a. American Standard.
   b. Sloan Valve Co.
   c. Zurn Industries.
3. Toilet Seat:
   a. American Standard
   b. Bemis Mfg. Co.
   c. Centoco Manufacturing Corp.
   d. Church Seat Co.
   e. Kohler.
   f. Zurn Plumbing Products
4. Flushometer Valve Operation: Diaphragm.
5. Flushometer Valve Finish: Polished, chrome-plated, exposed metal parts.
6. Flushometer Valve, Water Consumption: Factory set 1.28 gal. maximum per flushing cycle.
7. Flushometer valve components include the following:
   a. Brass, lever-handle actuation.
   b. Non-hold-open feature.
8. Toilet Seat: Solid-plastic, water-closet seat with bumpers and hardware, compatible with water closet and as follows:
   a. Class: Commercial, Extra-Heavy-Duty type, exceeding requirements of Commercial, Standard class.
   b. Size: Elongated.
   c. Hinge Type: Self-sustaining check (SC).
9. Water Closet Floor Flange: PVC closet flange with adjustable slotted metal ring.

3.9 URINAL SCHEDULE

A. Urinal: Where plumbing fixtures of this designation are indicated, provide products complying with the following and with the Plumbing Fixture Schedule on the drawings:

1. Vitreous-China Urinal:
   a. American Standard, Inc.
   b. Kohler Co.
   c. Sloan Valve Co.
   d. Zurn Plumbing Products

2. Flushometer Valve:
   a. American Standard.
   b. Sloan Valve Co.
   c. Zurn Industries, Inc
3. Flushometer Valve Construction: Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker.
4. Flushometer Valve Operation: Diaphragm.
5. Flushometer Valve Finish: Polished, chrome-plated, exposed metal parts.
6. Flushometer Valve, Water Consumption: Factory set 0.5 gal. maximum per flushing cycle.
7. Flushometer valve components include the following:
   a. Brass, lever-handle actuation.
   b. Non-hold-open feature.
8. Fixture Support: Type I, vertically adjustable, urinal, chair carrier with coupling; heavy-duty, rectangular-steel, upright members; bearing plate; and feet.

3.10 LAVATORY SCHEDULE

A. Lavatory: Where plumbing fixtures of this designation are indicated, provide products complying with the following and with the Plumbing Fixture Schedule on the drawings:

1. Vitreous-China Lavatory:
   a. American Standard, Inc.
   b. Kohler Co.
   c. Sloan Valve Co.
   d. Zurn Industries.
2. Faucet:
   a. American Standard, Inc.
   b. Chicago Faucet Co.
   c. Delta Faucet
   d. Kohler Co.
   e. Symmons Ind.
   f. T & S Brass and Bronze Works, Inc.
   g. Zurn Industries
3. Fitting Insulation Kit:
   a. TRUEBRO, Inc.
   b. McGuire
   c. Brocar
4. Supplies: See Fittings section of this specification.
5. Faucet Construction: Cast brass with ceramic cartridges and polished chrome finish.
6. Faucet Water Consumption: 1.5 or 0.5 gpm as specified on drawings.
7. Supply Insulation Kit: Molded, soft-plastic covering for supplies from wall to fixture with removable covering for stops and handles. Include manufacturer's standard fasteners, straps, and adhesives.
8. Drain Insulation Kit: Molded, soft-plastic covering for drain piping from fixture to wall. Include manufacturer's standard fasteners, straps, and adhesives.
9. Fixture Support: Type II, concealed arm; vertically adjustable, lavatory, chair carrier with heavy-duty, rectangular-steel, upright members; and feet.

3.11 SINK SCHEDULE

A. Accessible: Where plumbing fixtures of this designation are indicated, provide products complying with the following and with the Plumbing Fixture Schedule on the Drawings:

1. Stainless-Steel Sink:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing Co.
   c. Franke Kindred
   d. Advance Tabco
2. Faucet:
   a. American Standard, Inc.
   b. Chicago Faucet Co.
   c. Delta Faucet
   d. Kohler Co.
   e. Symmons Ind.
   f. T&S Brass and Bronze Works, Inc.
   g. Zurn Industries
3. Disposer:
   a. Emerson Electric Co.; In-Sink-Erator Div.
4. Sediment Plaster Interceptor:
   a. Josam Co.
   b. Smith: Jay R. Smith Mfg. Co.
   c. Tyler Pipe Industries, Inc.; Wade Div.
   d. Zurn Industries, Inc.
5. Fitting Insulation Kit:
   a. TRUEBRO, Inc.
   b. McGuire
   c. Brocar
6. Fixture Stainless-Steel Thickness: 18 gauge.
7. Fixture Mounting: Counter, self-rimming.
8. Faucet Construction: See Fixture Schedule for faucet styles.
9. Faucet Water Consumption: 2.0 gpm maximum flow.
10. Drain{s}: 1-1/2-inch removable, stainless-steel strainer bucket with 3-1/2-inch removable, stainless-steel crumb cup with 1-1/2-inch NPS tubular-brass tailpiece.
11. Interceptor Waste: 2-inch NPS, 0.045-inch-thick, (17 ga.) tubular-brass tailpiece.
12. Interceptor: Cast iron with interior and exterior, acid-resistant-enamel coating, sediment interceptor designed for floor mounting. Include 2-inch NPS, inlet and outlet; removable, corrosion-resistant screens or bucket; and 2-inch NPS, waste piping with wall flange.
13. Food-Waste Disposer: Household, continuous feed. Include 115 VAC, 1725-rpm motor with overload protection and reset button; wall switch; corrosion-resistant chamber with jam-resistant grinder or shredder; 1-1/2-inch NPS outlet; quick-mounting, stainless-steel sink flange; anti-splash guard; and combination cover/stopper.
    a. Model: 3/4-hp, model with cutlery- or stainless-steel grinder or shredder. shredder and sound-insulated chamber. shredder, sound-insulated chamber, and stainless-steel outer shell.
14. Supplies: See Fittings section of this specification.

3.12 MOP-SERVICE BASIN SCHEDULE

A. Mop-Service Basin: Where plumbing fixtures of this designation are indicated, provide products complying with the following and with the Plumbing Fixture Schedule on the drawings:

1. Mop-Service Basin:
   a. Fiat Products, Inc.
   b. Forestone
   c. Stern-Williams Co., Inc.

2. Faucet:
   a. American Standard, Inc.
   b. Chicago Faucet Co.
   c. Delta Faucet
   d. Kohler Co.
   e. Speakman Co.
   f. T & S Brass and Bronze Works, Inc.
   g. Zurn Industries
3. Fixture Dimensions: See Plumbing Fixture Schedule on drawings.
4. Mounting: Floor.
5. Rim Guard: Manufacturer's standard.
6. Faucet: Widespread, cast brass with supplies on 8-inch centers.
7. Faucet Mounting: Wall, centered on fixture.
8. Faucet Components: Include the following:
   a. Finish: Rough chrome.
   b. Handles: Dual lever or 4 arm.
   c. Supply Stops: Integral, in shanks.
   d. Spout: With integral vacuum breaker, pail hook, and hose-thread outlet.
   e. Wall Brace: Assembly with wall bracket and support to faucet spout.
   f. Hose: 30-inch-minimum, flexible hose with stainless-steel hose wall bracket.
9. Drain: 3-inch NPS with grid strainer.
10. P-Trap: 3-inch NPS drainage piping.
11. Supplies: 1/2-inch NPS copper tubing with supply stop.
12. Reinforcement: Provide for wall-mounting faucet, wall brace, and hose-hook bracket.

3.13 ELECTRIC WATER COOLER SCHEDULE

A. Electric Water Cooler: Where plumbing fixtures of this designation are indicated, provide products complying with the following and with the Plumbing Fixture Schedule on the drawings:

1. Water Coolers:
   a. Acorn Aqua; Acorn Mfg. Co.
   b. Elkay Manufacturing Co.
   c. Halsey Taylor.
   d. Haws Drinking Faucet Co.
   e. Oasis
2. Fixture Type: Bubbler.
3. No. of Bubblers or Stations: One.
4. Fixture Cabinet Material: Stainless steel.
5. Fixture Mounting: Wall.
6. Wall Grille: Stainless steel.
7. Bottled Water Supply: Include bottle water supply with sensor operation.
8. Supply: 3/8-inch NPS copper tubing with supply stop.

3.14 KITCHEN EQUIPMENT FURNISHED BY OTHER DIVISION

A. Kitchen Fixture Equipment: Where plumbing fixtures of this designation are indicated and provide products complying with the following and with the drawings:

1. Products: Subject to compliance with requirements, provide one of the following:
2. Supply Inlet: 1/2-inch NPS
3. Supply Stop: Globe or ball valve.
4. Supply Riser: Rigid copper supply, size as determined by equipment inlet.
5. Drain: Connect to equipment drain outlet and route drain piping to drain receptor. Use DWV copper piping and fittings. Make indirect connection at drain receptor unless noted otherwise.

END OF SECTION 224000

SECTION 224050

ELEVATOR SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of pumps for permanent installation in plumbing systems:

1. Sump pumps.

1.3 DEFINITIONS

A. Permanent-Installation Pumps: Type suitable for fixed installation and connection to piping systems.

B. Submersible Pumps: Type that operates with motor submerged in water.

C. Sump Pumps: Type suitable for lifting waste-water not containing solids from a sump or wet location to a point of discharge. Pumps normally have strainer on inlet. This type includes wet-pit-mounted, vertical sump pumps and submersible sump pumps.

D. Oil Detection System: Detection system with oil sensing probes which detect presence of oil and hydraulic fluid. Positive detection of oil by probes will activate alarm and shutdown sump pump.

1.4 PUMP PERFORMANCE REQUIREMENTS

A. Pump Pressure Ratings: At least equal to maximum pump-operating pressure.

1.5 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and other Division Specification Sections.

B. Product data including certified performance curves, weights (shipping, installed, and operating), furnished specialties, alarms, probes and accessories. Include startup instructions.

C. Shop drawings showing layout and connections for pumps and detection systems. Include setting drawings with templates, directions for installation of foundation and anchor bolts, and other anchorages.

D. Wiring diagrams detailing wiring for power, signal, and control systems differentiating between manufacturer-installed wiring and field-installed wiring.

E. Product certificates signed by pump manufacturers certifying accuracies under specified operating conditions and compliance with specified requirements.

F. Maintenance data for each type and size pump specified to include in the "Operating and Maintenance Manual."

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following:

1. ASME B31.9 "Building Services Piping" for piping materials and installation.

2. H.I. "Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps" for pump design, manufacture, and installation.
3. UL 778 "Standard for Motor Operated Water Pumps" for construction requirements. Include UL listing and labeling.
4. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labeling.
5. NFPA 70 "National Electrical Code" for electrical components and installation.

B. Single-Source Responsibility: Obtain same type of pumps from a single manufacturer with pumps, components, and accessories from a single source. Include responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

C. Design Criteria: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Design Professional. The burden of proof for equality of pumps is on the proposer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pumps in a clean, dry location.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, or other foreign matter.

D. Comply with pump manufacturer's rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Submersible Sump Pumps:
   a. Aurora Pumps, General Signal.
   b. Federal Pump Corp.
   c. Flygt Corp. Subsid., ITT Fluid Technology Corp.
   d. Goulds Pumps, Inc.
   e. Grundfos Pumps Corp.
   f. Liberty Pumps.
   g. Little Giant Pump Co. Subsid., Tecumseh Products Co.
   h. F.E. Myers, Pentair Co.
   i. Paco Pumps, Inc.
   j. Stancor, Inc.
   k. Sta-Rite Industries, Inc.
   l. Weil Pump Co.
   m. Zoeller Co.

2.2 PUMPS, GENERAL

A. Plumbing Pumps: Factory assembled and tested, and of construction required for permanent installation.

B. Motors: NEMA MG 1; single speed with type of enclosure and electrical characteristics indicated. Include built-in thermal-overload protection and grease-lubricated ball bearings. Motors are non-overloading within full range of pump performance curves.

C. Finish: Manufacturer's standard paint applied to factory-assembled and -tested plumbing pump unit prior to shipping.

D. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3 SUMP PUMPS

A. General Description: Centrifugal, end-suction, single-stage sump pump, with inlet strainer, motor, and operating controls.

B. Impeller: Cast iron or cast bronze, statically and dynamically balanced, open or semi-open, overhung, single suction, keyed to shaft, and secured by locking cap-screw.

C. Submersible, Waste-Water Sump Pumps: Simplex, submersible, direct-connected type, with basin cover with holes with gaskets in cover as required.

1. Casing: Cast iron with integral, cast-iron inlet strainer and stainless steel hardware. Include discharge companion flange arranged for vertical discharge and suitable for plain-end pipe connection.
2. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
3. Seal: Mechanical seal.
4. Motor: Hermetically sealed capacitor-start type, with built-in overload protection. Include a 3-conductor waterproof power cable of length required, but not less than 10 feet, with a grounding plug and cable-sealing assembly for connection at pump.
5. Motor Housing: Stainless steel with stainless steel hardware.
6. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe, bronze pipe, or copper tube, except where specific material is indicated.

2.4 GENERAL-DUTY VALVES

A. Refer to other Division 22 sections for general-duty gate, ball, butterfly, globe, and check valves.

2.5 PUMP CONTROLS

A. Float Switch Controls: 120 volts a.c., NEMA 250, Type 6 micro-pressure or mercury float switches, mounted on discharge piping.

B. Oil Sensing Controls: Control unit shall consist of oil detection probes and a float switch. Operation of pump shall be based on the following:

1. Position of float switch will determine if pump is operating.
2. If oil sensor probe detects presence of oil, then controller will suspend operation of pump to prevent the pumping of oil.
3. High water alarm will be activated by a separate probe or float switch.

2.6 OIL-SENSING PUMP CONTROL PANEL

A. Control panel shall be UL Listed and include pump system controls, power cord and alarms. Audible and visual high-water alarms shall be included. Control panel shall include a contact for connection to a remote alarm. Include cables connections to oil-sensing probes. Include field adjustable switch for oil-sensitivity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present for compliance with requirements for installation and other conditions affecting performance of pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections prior to pump installation.

3.2 INSTALLATION

A. General: Comply with pump manufacturer's written installation instructions.

B. Install pumps in locations indicated and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support piping so that weight of piping is not supported by pumps.

D. Submersible Sump Pumps: Install submersible sump pumps, set on basin, pit, or sump floor. Make direct connections to storm drainage piping.

E. Mount pump control panel in an accessible location.

3.3 CONNECTIONS

A. General: Connect piping to pumps as indicated. Install valves that are same size as piping connecting to pumps.

B. Install discharge pipe sizes equal to or greater than diameter of pump nozzles.

C. Install check valve and gate or ball valve on each sump pump discharge.

D. Install electrical connections for power, controls, and devices.

E. Electrical power and control wiring and connections are specified in Division 26 Sections.

3.4 ADJUSTING

A. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

3.5 COMMISSIONING

A. Final Checks Before Startup: Perform the following preventive maintenance operations and checks before startup:

1. Lubricate oil-lubricated-type bearings.
2. Remove grease-lubricated bearing covers and flush bearings with kerosene and thoroughly clean. Fill with new lubricant according to manufacturer's recommendations.
3. Disconnect couplings and check motors for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pumps are free to rotate by hand. Do not operate pump, if bound or even drags slightly, until cause of trouble is determined and corrected.
5. Check that pump controls are correct for required application.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power:

1. Start motors.
2. Open discharge valves slowly.
3. Observe leakage from stuffing boxes and adjust sealing liquid valves for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
4. Check general mechanical operation of pumps and motors.

END OF SECTION 224050

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SECTION 224600

SECURITY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following security plumbing fixtures and related components:

1. Security combination units.

1.3 DEFINITIONS

A. Accessible Fixture: Security plumbing fixture that can be approached and used by people with disabilities.

B. Front-Mounting-Type Fixture: Security plumbing fixture designed to mount on fixture support with installation and removal from fixture side of wall, and piping and other components are accessible from access panels in fixture or wall.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include furnished specialties and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For security plumbing fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities about security plumbing fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

PART 2 - PRODUCTS

2.1 COMBINATION UNITS

A. Security Combination Units:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on the Plumbing Fixture Schedule or a comparable product by one of the following:
   a. Acorn Engineering Company.
   b. Bradley Corporation.
   c. Willoughby Industries, Inc.
2. Material: 0.078-inch- (2.0-mm-) minimum-thick, 14 GA, type 304 stainless steel.
3. Standard: ASME A112.19.3/CSA B45.4.
4. Finish: Exposed stainless-steel surfaces polished to a No. 4 satin finish.
5. Toilet Paper Holder: Recessed stainless steel.
6. Grab Bar: Ligature-resistant type with closure plate.
7. Mounting: 1/2 inch (13 mm) threaded rod with nuts and washers through wall into accessible service space.
8. Controls: Electronic controls with PZPB Piezo electric push-button.
9. Water Closet:
   a. Bowl:
      1) Type: Elongated, with back inlet, integral trap, and Siphon-jet design with Floor outlet and contoured seat.
      2) Seat Surface: No. 4 satin finish.
      3) Retain either "Wall Outlet Connection" or "Floor Outlet Connection" subparagraph below.
      4) Floor Outlet Connection: Water closet gasket waste.
      5) Flange and bolts supplied by Contractor.
      6) Consumption: 1.28 GPF flush valve.
      7) Toilet Overflow Preventer: Electronic vacuum-operated disabler with integral vacuum generator and integral bowl overflow sensor.
      8) Ligature-resistant Water Closet Bowl Skirt: Yes.
10. Coordinate with “Flushometer Valve” Article.
11. Lavatory:
   b. Standard: NSF/ANSI 61, NSF/ANSI 372.
   c. Location: In top of cabinet.
   d. Receptor: Bowl with integral, self-draining, soap depression.
   e. Bubbler/Filler: Ligature-resistant hemispherical filler, machined type 303 stainless steel. No chrome-plated brass allowed.
   f. Pushbuttons and Escutcheons: Machined type 303 stainless steel. No chrome-plated brass allowed.
   g. Lavatory Water Supply Valve:
      1) Standard: ASME A112.18.1/CSA B125.1.
      2) Valve Type: Electronic adjustable with individual check stops.
      3) Temperature: Single temperature.
   h. Drain: Fast integral punched grid.
   i. Trap Location: Integral NPS 1-1/2 (DN 40) complying with ASME A112.18.2/CSA B125.2.
   j. Lavatory Overflow: Yes.
12. Wall Sleeve for Masonry/Precast Walls: Galvanized steel frame of dimensions required to match fixture including ½-inch (13 mm) steel rebar to prevent escape if fixture is removed.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before security plumbing fixture installation.

B. Examine floors and walls for suitable conditions where security plumbing fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SECURITY PLUMBING FIXTURE INSTALLATION

A. Install back-mounting-type, stainless-steel security plumbing fixtures as follows:

1. Install wall sleeve in wall.
2. Install fixture on wall sleeve; mount components on or attached to wall sleeve with access from accessible service space.
3. Extend supply piping from service space to fixture.
4. Install soil and waste piping from fixture and extend into service space.
5. Install fixture trap in service space instead of below fixture drain.

B. Install front-mounting-type, stainless-steel security plumbing fixtures as follows:

1. Install fixture support or mounting bracket.
2. Install fixture on support; mount components inside of or attached to fixture.
3. Extend supply piping from pipe space to fixture.
4. Install trap below fixture and extend soil and waste piping into pipe space.

C. Install security plumbing fixture outlets with gasket seals.

D. Install fixtures designated "accessible" according to ICC A117.1 for heights, dimensions, and clearances.

E. Install fixtures level and plumb.

F. Install shutoff valves in water-supply piping to fixtures.

G. Install dielectric fittings in water-supply piping to fixtures if piping and fixture connections are made of different metals.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot- and cold-water supply piping to security plumbing fixtures. Include supply stops, if specified, or ball valve on each supply.

C. Connect soil and waste piping to security plumbing fixtures.

D. Ground equipment according to Division 26.

E. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Testing: After installing security plumbing fixtures and after electrical circuitry has been energized, test for compliance with requirements.
2. Remove and replace malfunctioning security plumbing fixtures. Retest as specified above after repairs or replacements are made.

3.5 ADJUSTING

A. Operate and adjust water-supply flushometers and flow-control valves on security plumbing fixtures.

3.6 CLEANING

A. Clean security plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall spouts and strainers.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed security plumbing fixtures and fittings.

B. Do not allow use of security plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224600

SECTION 230000

GENERAL HVAC PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes general provisions covering the contract documents for HVAC Systems.

1.3 DEFINITIONS

A. Provide shall mean "Furnish, install and connect."

B. Piping shall mean "pipe installed with all specified fittings, valves and accessories, and forming a complete system."

C. HVAC shall mean "Heating, Ventilation and Air Conditioning."

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Electrical Coordination: In addition to submittal requirements of other Division 23 Sections, submit a document approved by the project Electrical Contractor certifying that all mechanical equipment being furnished under Division 23 complies with the electrical characteristics of the source power which will be furnished under Division 26.

C. Extra Materials: Where specification sections call for extra materials (i.e., filters, etc.) submit a complete list of all such materials including total quantities and sizes for review. Delivered quantities will be verified at the completion of the project.

1. Upon delivery of the extra materials to the Owner, an Owner’s representative shall sign the materials list certifying receipt.
2. The signed receipt shall be included in the closeout documents.

D. Model numbers listed on the Mechanical Contract Documents shall not be construed to indicate electrical characteristics. Electrical characteristics of mechanical equipment shall be as indicated on the Electrical Contract Documents (Division 26).

E. Review of Submittals does not relieve the Contractor of any of the requirements of the Contract Documents. Failure by the Engineer to document errors and omissions in the Contractor's submittals during the Engineer's submittal review does not constitute a waiver of any of the requirements of the original sealed Contract Documents.

1.5 CONTRACTOR QUALIFICATIONS

A. HVAC Subcontractor shall have a current Class II (Non-restricted) Conditioned Air Contractors License for the state in which the project is being constructed. The Subcontractor shall have as part of the Firm a Service Department qualified to service all systems installed in the project or have a written agreement with a Service Agency qualified to provide such service. The Service Department or Agency shall be on call at all hours. The subcontractor shall have installed at least (within the last five years):

1. Three (3) hydronic water systems of at least 150-tons in size.
2. One heat recovery variable refrigerant flow system of at least 20-tons in size.
3. Three Dx system buildings of at least 100-tons total capacity with more than one system in excess of 5-tons

1.6 PRIOR APPROVALS

A. Manufacturers References: When reference is made in the Contract Documents to trade names or specific manufacturers and/or models, such reference, unless noted otherwise, is made to designate and identify the quality of materials or equipment to be furnished and is not intended to restrict competitive bidding. If it is desired to use materials or equipment different from those indicated on the Contract Documents, written request for approval must reach the hands of the primary Design Professional at least TEN DAYS prior to the date set for the opening of bids. A copy of the request should also be sent directly to the Engineer. Requests for prior approval of a proposed substitute shall be accompanied by complete technical data supporting the request.

1.7 LAYOUT AND COORDINATION

A. Layout Basis:

1. The equipment listed on the drawing schedules or in the technical specifications as “basis of design” or “owner preferred” has been used for the physical arrangement of the mechanical systems. When equipment listed as acceptable, equal or equipment which has received "prior approval" is used, it shall be the Contractor's responsibility to provide structural, ductwork, electrical, service clearances, or other changes required to accommodate the substituted equipment. Changes shall be made at no additional cost to the Owner. Submit a list of required changes along with all prior approval requests and shop drawing submittals.
2. The Contract Drawings are intended to show the general arrangement of all mechanical work. They do not show in detail all offsets, fittings and transitions. Examine Drawings, investigate site conditions to be encountered and arrange work accordingly. Furnish all offsets and transitions required.
3. Drawings do not indicate in detail exact configuration of connections for fixtures, equipment and accessories. Final connection shall be as shown on approved Manufacturer's Submittal Drawings. Where Manufacturer's Submittal Drawings conflict with the Contract Documents, confer with the Design Professional for resolution.
4. Measurement of Drawings by scale shall not be used as dimensions for fabrication. Measurements for locating fixtures, equipment, ductwork, piping and other mechanical items shall be made on the site and shall be based on actual job conditions.
5. Check space limitations and verify electrical requirements before ordering any mechanical equipment or materials. Place large equipment inside the building prior to the erection of exterior walls where equipment cannot enter finished building openings.

B. Coordination: Mechanical work shall be coordinated with that of other trades to avoid conflict. The Contractor shall study all plans and specifications for this project and shall notify the Design Professional of any conflict between work under Division 23 and work under other divisions of the Project. Particular attention shall be given to interference between piping, electrical installations, structural systems, building openings and ductwork.

C. Installation Instructions: Manufacturer's installation instructions for all equipment furnished under Division 23 shall be furnished by the Contractor. Instructions shall be maintained on the jobsite until the project is complete, and then turned over to the Owner.

D. Operation and Maintenance Instructions: Electronic copies of equipment O&M manuals shall be submitted to the Owner a minimum of 15 days prior to equipment/systems training. An index document indicating project name, project number, building name and contents shall be included. Model and serial numbers of equipment shall be shown on the cover of their respective O&M manual(s). Warranty registration documentation shall be included where applicable, including documentation confirming warranties have been registered with the equipment manufacturer.

1.8 PERMITS

A. Obtain all necessary Permits and Inspections required for the installation of this work and pay all charges incident thereto. Deliver to the Design Professional all certificates of inspection issued by authorities having jurisdiction.

B. Sewer tap fees, water tap fees, meter fees, Dept. of Labor Fees for Boilers and Pressure Vessels and all other charges for work under Division 23, including charges for meter installation and excess service by the Gas Company or any other utilities shall be paid by the Contractor.

1.9 SAFETY

A. OSHA Requirements applicable to the project shall be complied with at all times.

B. Manufacturer's Safety Instructions shall be followed in all instances.

C. Asbestos Containing Materials (ACM) shall not be used on this project.

D. Refrigerants containing CFC’s or HCFS’s shall not be used on this project, nor shall any equipment using such refrigerants be incorporated into this project.

E. Electrical Equipment Clearances: Piping, equipment and other mechanical installations shall not be located within 42" of the front or 36" of the side of any electrical switchboards, panelboards, power panels, motor control centers, electrical transformers or similar electrical equipment. Piping and ductwork shall not pass through or above electrical equipment rooms except as required to serve those rooms.

F. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof or grade below. The guard shall extend not less than 30 inches beyond each end of such appliances, equipment, fans, components and roof hatch openings and the top of the guard shall be located not less than 42 inches above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21-inch diameter sphere and shall comply with the loading requirements for guards specified in the International Building Code.

1.10 PROTECTION OF MECHANICAL SYSTEMS AND COMPONENTS DURING CONSTRUCTION

A. Material storage:

1. All materials and equipment stored on the jobsite shall be elevated above the ground and stored under suitable weather cover. Materials and equipment shall not be situated in areas subjected to localized flooding.
2. Manufacturer’s original shipping packaging and protective coverings shall be left in place until the equipment is prepared for installation.

B. Roof protection: All penetrations through roofs, including roof curbs, piping curbs and roof drainage system elements shall be properly protected during construction to prevent water

intrusion into the building. Protective measures could include temporary covers and plugs, as well as other appropriate temporary elements.

C. Electrical enclosure protection:

1. During construction, all protective covers and other devices shall be left in place that protect against inadvertent contact with live electrical circuits.
2. All warning labels related to electrical and rotating equipment hazards shall be in place prior to energizing mechanical equipment circuits.

D. Protection of ducts and piping:

1. Maintain temporary closures on the ends of all ducts and pipes as the installation work progresses. Temporary closures include plastic sheeting, tape and appropriate caps and covers.
2. Where debris enters piping during installation, steps shall be taken to clean the interior of the pipe prior to placing in service.
3. Where debris enters ductwork during installation the duct interior shall be cleaned prior to placing in service.

E. Operation of HVAC systems during construction:

1. Although the operation of the permanent HVAC systems during the construction process is strongly discouraged, the Contractor shall take measures to protect the systems from contamination if they are operated.
2. When placed in operation during the construction period, all HVAC systems shall have MERV 8 filtration in all standard filter racks throughout the systems. Where so equipped, final filter banks do not have to be in place.
3. All return and outdoor air intake openings shall be protected with MERV 8 filter material at all points of entry into the duct system. These protections shall be maintained and remain in place until the building is prepared for final inspection.
4. Prior to final acceptance of the building HVAC systems, the interior of all HVAC unit cabinets shall be thoroughly cleaned to “like-new” condition.

1.11 CODES AND STANDARDS

A. Mechanical installations shall conform to the current edition (recognized by the State) of the following, in addition to any previously mentioned Codes and Standards.

1. The International Building Code.
2. The International Mechanical Code.
3. The International Plumbing Code.
4. The International Fire Protection Code.
5. The State Energy Code.
6. NFPA Standard 70, National Electric Code.
7. NFPA Standard 90A, Installation of Air Conditioning and Ventilation Systems.
8. NFPA Standard 101, Code for Safety to Life for Fire in Buildings and Structures.

1.12 INTERRUPTION OF EXISTING SERVICES

A. Exercise care so as not to cut any existing utilities or services. Where an existing utility line or service line is cut it shall be repaired to "like-new" condition. Interruption of service shall not be made without prior written permission of the Owner.

B. Plumbing, Electrical and HVAC system must remain in service during construction. Arrange with the Owner well in advance of shutdowns required for tie-ins. Shutdowns shall be made after normal occupancy hours if so directed by the Owner. No additional monies will be paid for after-hours shutdowns.

PART 2 - PRODUCTS Not required for this section.

PART 3 - EXECUTION Not required for this section.

END OF SECTION 230000

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SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete equipment base construction requirements.
3. Equipment nameplate data requirements.
4. Non-shrink grout for equipment installations.
5. Field-fabricated metal and wood equipment supports.
6. Installation requirements common to equipment specification Sections.
7. Mechanical demolition.
8. Cutting and patching.
9. Touchup painting and finishing.
10. Pipe-Freeze-Protection Heating Cables.

B. Pipe and pipe fitting materials are specified in piping system Sections.

1.3 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for following piping specialties:

1. Mechanical sleeve seals.
2. Identification materials and devices.
3. Pipe freeze protection heating cables.

C. Samples of color, lettering style, and other graphic representation required for each identification material and device.

D. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

E. Coordination drawings for access panel and door locations.

F. Prepare coordination drawings of Mechanical Rooms and Yards to a ¼-inch equals 1 foot scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

1. Proposed locations of piping, ductwork, equipment, and materials. Include the following:
   a. Planned piping layout, including valve and specialty locations and valve stem movement.
   b. Planned duct systems layout, including elbow radii and duct accessories.
   c. Clearances for installing and maintaining insulation.
   d. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
   e. Equipment service connections and support details.
   f. Exterior wall and foundation penetrations.
   g. Fire-rated wall and floor penetrations.
   h. Sizes and location of required concrete pads and bases.
2. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

G. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code--Steel."

B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

C. ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

D. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

E. Coordinate all electrical service requirements for mechanical equipment prior to the submittal of shop drawings. Confirm the compatibility of all power services with the equipment being furnished. Confirm compatibility of electrical lugs being provided by the equipment manufacturer with the power wiring being furnished under Division 26. Furnish written documentation that all characteristics have been coordinated with and confirmed by the electrical subcontractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 23 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch minimum thickness, except where thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face, 1/8-inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.

E. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 PIPING SPECIALTIES

A. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly for 250-psig minimum working pressure at a 180 deg F temperature.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.
6. Dielectric Couplings: Galvanized-steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F temperature.
7. Brass Fittings: It is acceptable to use brass fittings in lieu of dielectric fittings to transition from ferrous to non-ferrous piping.

B. Mechanical Sleeve Seals: Modular, watertight mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.

C. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.
   a. Penetrating Pipe Deflection: 5 percent without leakage.
   b. Housing: Ductile-iron casting having water-stop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.
   c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
   d. Housing-to-Sleeve Gasket: Rubber or neoprene push-on type of manufacturer's design.

D. Piping Roof Curbs:

1. Curb and cap shall be constructed of minimum 18-guage galvanized sheet metal with continuous welded seams.
2. Provide cant-strip at the base of curb for flashing.
3. Line curb with 1½-inch fiberglass insulation.
4. Galvanized sheet metal cap shall have welded sheet metal collars (sleeves) for each pipe that allow for installation of insulated pipe.
5. Seal annular space between pipe/insulation and collar with a flexible weatherproof boot and stainless-steel pipe clamps.
6. Cap shall be secured to the curb nailer with cadmium plated screws; minimum one per side.

2.4 IDENTIFYING DEVICES AND LABELS

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

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped, permanently fastened to equipment.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
2. Location: An accessible and visible location.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid snap-on, color-coded pipe markers, conforming to ASME A13.1.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, conforming to ASME A13.1.

E. Valve Tags: Engraved brass numbered tags on steel chain.

F. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine sub-core, except when other colors are indicated.

1. Fabricate in sizes required for message.

2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
3. Punch for mechanical fastening.
4. Thickness: 1/16 inch, except as otherwise indicated.
5. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

G. Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of the above criteria.
6. For hazardous equipment, use colors and designs recommended by ASME A13.1.
7. Nomenclature: Include following, matching terminology on schedules as closely as possible:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.
8. Size: Approximately 2-1/2 by 4 inches for control devices, dampers, and valves; and 4-1/2 by 6 inches for equipment.

H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."

2.5 GROUT

A. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

2.6 PIPE-FREEZE-PROTECTION HEATING CABLES (HEAT TRACE)

A. Self-regulating, electric heating cables suitable for freeze protection of metal or plastic piping as indicated. Cables and components shall be UL Listed.

B. Temperature, wattage, and voltage ratings as indicated (5 watts per linear foot unless indicated otherwise).

C. Heating cables shall maintain 40°F and shall be sized on an ambient temperature of 15°F.

D. Heater output reduction at least 90 percent from 40 to 150 deg F pipe temperature.

E. Pair of parallel 16 AWG tinned-copper bus wires are embedded in cross-linked conductive polymer core, which varies power output in response to temperature along its length.

F. Cable suitable for crossing over itself without overheating.

G. Cable cover fabricated of cross-linked, modified, polyolefin dielectric jacket and tinned-copper braid, and polyolefin outer jacket.

H. Heat traced piping shall have labels on the exterior of the piping insulation, stamped “ELECTRIC TRACED”. Labels shall be spaced no more than 10-feet on center.

I. Capacities and Characteristics:

1. Contractor shall size the heat trace system based on approved piping shop drawings.
2. Heat trace shall maintain 40°F and shall be sized based on an ambient temperature of 15°.
3. All electrical requirements shall be determined by coordinating with the electrical contractor.

J. Controls:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F. Set to disable heating cables at 40 deg. F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. NEMA 3R enclosure.

K. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended by manufacturer.

L. Install insulation over piping with electric cables. Install electric heating cables according to IEEE 515.1.

M. Install warning tape on piping insulation where piping is equipped with electric heating cables.

N. Set field-adjustable switches and circuit-breaker trip ranges.

O. Protect installed heating cables, including non-heating leads, from damage.

P. Test cables for electrical continuity and insulation integrity before energizing. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

Q. Warranty Period: 10 years from date of Material Completion

R. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chromalox, Inc.
2. Raychem
3. Thermon

2.7 FIRE-STOPPING

A. Fire-Resistant Sealant: Provide UL Listed firestopping system for filling openings around penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

B. Products: Subject to compliance with requirements, provide products by one of the following:

1. Specified Technologies, Inc.
2. 3M Corporation
3. Metacaulk.
4. Hilti, Inc.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS--COMMON REQUIREMENTS

A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 23 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

C. Install piping at indicated slope.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

K. Install fittings for changes in direction and branch connections.

L. Install couplings according to manufacturer's printed instructions.

M. Install sleeves for pipes passing through concrete and masonry walls, concrete floor and roof slabs, exterior walls and where indicated.

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.
2. Build sleeves into new walls and slabs as work progresses.
3. Install large enough sleeves to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than 6 inches.
   b. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.

c. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Flashing is specified in other division sections.
   1) Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.

4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation in non-rated floors and partitions, using elastomeric joint sealants. EXCEPTION: Fire rated partition penetrations shall be sealed with U.L. Listed firestopping systems.

N. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and elastomeric sealant. Size sleeve for ½-inch annular clear space between pipe and sleeve for installation of sealant.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install sheet metal sleeve assembly for sleeves 6 inches and larger.
3. Install cast iron sleeves according to manufacturer's preprinted instructions.

O. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

P. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with U.L. Listed firestopping sealant system.

Q. Verify final equipment locations for roughing in.

R. Refer to equipment specifications in other Sections for roughing-in requirements.

S. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS "Soldering Manual," Chapter 22 "The Soldering of Pipe and Tube."
4. Brazed Joints: Construct joints according to AWS "Brazing Manual" in the "Pipe and Tube" chapter.
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
   a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
   b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
   c. Align threads at point of assembly.
   d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
   e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

f. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to the "Quality Assurance" Article.

6. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

T. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.
2. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Install dielectric unions and flanges or brass fittings to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION--COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Design Professional.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

F. Equipment and appliances containing evaporators or cooling coils shall be installed with a means of condensate removal in compliance with IMC 307.2. A water level detection device conforming to UL 508 shall be provided for all main condensate pans and be interlocked to de-energize the unit’s main fan should the drain pan water level exceed the main drain pipe connection level. Additional measures shall be taken where indicated on drawings or specifications.

3.3 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: Complying with ASME A13.1.
2. Plastic markers, with application systems. Install on pipe insulation segment where required for hot non-insulated pipes.
3. Locate pipe markers wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), and exposed exterior locations as follows:
   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 flow pattern is not obvious.
c. Near locations where pipes pass through walls, floors, ceilings, or enter inaccessible enclosures.
d. At access doors, manholes, and similar access points that permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.
f. Spaced at a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.

4. On piping above removable acoustical ceilings, provide as noted in the previous paragraph, except omit intermediately spaced markers.

B. Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.

1. Lettering Size: Minimum 1/4-inch -high lettering for name of unit where viewing distance is less than 2 feet, 1/2-inch -high for distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
2. Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.

C. Mark all above ceiling devices such as valves, fire dampers, pumps and HVAC equipment with signs located on the ceiling below.

D. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows, showing duct system service and direction of flow.

1. Location: In each space where ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet.

E. Adjusting: Relocate identifying devices which become visually blocked by work of this Division or other Divisions.

3.4 PAINTING AND FINISHING

A. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

B. Paint all exposed steel surfaces of piping and supports with one coat of primer and two coats of enamel.

3.5 CONCRETE BASES

A. Construct concrete equipment bases of dimensions indicated, but not less than 4 inches larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive strength concrete with 6 x 6 x #10 reinforcing wire mesh. Outdoor concrete bases shall extend a minimum of 4" above grade and be a minimum thickness of 6".

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.8 DEMOLITION

A. Disconnect, demolish, and remove work specified under Division 23 and as indicated.

B. Where pipe, ductwork, insulation, or equipment to remain, is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated pipe and ductwork in its entirety. Cap existing piping and ductwork that remains in place.

D. Abandoned Work: Cut and remove pipe abandoned in place, 2 inches beyond the face of adjacent construction. Cap piping and patch surface to match existing finish.

E. Removal: Remove indicated equipment, piping and ductwork from the Project site unless noted otherwise.

F. Where equipment is indicated to be demolished and removed, and utility runouts are not designated for re-use:

1. Remove associated gas hydronic, steam and refrigerant runout piping from the equipment back to the branching point or source unit. Cap remaining pipe and reinsulate as required.
2. Remove associated power wiring and raceway back to circuit protection device. Re-label circuit protection device.
3. Remove associated control devices, and control wiring.

G. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

H. Where floor-mounted equipment is removed, concrete pads shall be removed unless designated for re-use.

I. Remove all hangers, supports and anchors associated with mechanical items being removed. Patch surfaces to match adjacent finishes.

3.9 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.10 GROUTING

A. Install nonmetallic non-shrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms for placement of grout, as required.

D. Avoid air entrapment when placing grout.

E. Place grout to completely fill equipment bases.

F. Place grout on concrete bases to provide a smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's printed instructions.

END OF SECTION 230500

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SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed and field-installed motors.

1.3 SUBMITTALS

A. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

B. Factory Test Reports: For specified tests.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.

1. Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 BASIC MOTOR REQUIREMENTS

A. Motors shall be manufactured by one of the following:

1. Cutler Hammer
2. General Electric
3. Allen Bradley
4. Furnas
5. Siemens
6. Square D
7. Westinghouse
8. Baldor
9. U.S. Motors

B. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.

C. Frequency Rating: 60 Hz.

D. Voltage and Phase Rating: Determined by electrical characteristics of circuit to which motor is connected.

E. Service Factor: According to NEMA MG 1, unless otherwise indicated. All motors shall have a minimum service factor of 1.15.

F. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding 90% of nameplate ratings or considering service factor.

G. Enclosure: Open drip-proof, for indoor locations, totally enclosed fan cooled (TEFC) for outdoor locations except as otherwise indicated.

2.2 POLYPHASE MOTORS

A. Description: NEMA MG 1, medium induction motor.

1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
2. Electric motors shall meet the minimum efficiency requirements of the International Energy Conservation Code.
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.
5. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer. Motors shall be suitable for inverter duty in accordance with NEMA MG 1, Part 31.

1. Critical vibration frequencies are not within operating range of controller output.
2. Temperature Rise: Match rating for Class B insulation.
3. Insulation: Class F.
4. Thermal Protection: Where indicated, conform to NEMA MG 1 requirements for thermally protected motors.

C. Rugged-Duty Motors: Where indicated, motors are totally enclosed with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings are insulated with non-hygroscopic material. External finish is chemical-resistant paint over corrosion-resistant primer.

D. Source Quality Control: Perform the following routine tests according to NEMA MG 1:

1. Measurement of winding resistance.
2. No-load readings of current and speed at rated voltage and frequency.
3. Locked rotor current at rated frequency.
4. High-potential test.
5. Alignment.

2.3 SINGLE-PHASE MOTORS

A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.
4. Electronically commutated motor.

B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.

C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.

D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, pre-lubricated sleeve bearings for other single-phase motors.

E. Electronically Commutated Motors:

1. Where indicated, motor shall be an electronically commutated (EC) motor specifically designed for HVAC applications. Where EC motors are indicated, AC induction type motors are not acceptable.
2. EC motors shall be permanently lubricated with heavy-duty ball bearings to match the load and application. Motors shall be prewired to the specified voltage and phase. Internal motor circuitry shall convert AC power supplied into DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC external signal. Motor shall be a minimum of 85% efficient at all speeds.
3. All EC motors shall feature soft-start technology which eliminates inrush current at start-up. The motors will reliably start at any speed setting.
4. EC motor overload protection shall be provided such that, if the motor becomes overloaded, it will automatically reduce its speed until it is no longer overloaded. If the motor encounters a locked-rotor scenario, the motor shall automatically shut itself down. After shutdown, motor will attempt to restart up to 3 times, and if after the 3rd time the motor will still not rotate, the motor will not attempt to start again until power is cycled.
5. EC motors shall have a one-shot fuse thermal protector, intended to protect the motor from a severe temperature rise. Additionally, the motors shall have on-board temperature sensors which will reduce the speed of the motor should it become too hot.

2.4 SHAFT GROUNDING RINGS

A. Manufacturers: Shaft grounding rings shall be manufactured by AEGIS.

B. Description: Rings installed over motor shafts designed to divert bearing currents to ground by providing a reliable shaft grounding path through the motor frame.

1. Construction: Solid or split rings with 2 rows of conductive microfibers externally or internally mounted to the motor frame.

PART 3 - EXECUTION

3.1 ADJUSTING

A. Use adjustable motor mounting bases for belt-driven motors.

B. Align pulleys and install belts.

C. Tension according to manufacturer's written instructions.

3.2 APPLICATIONS

A. Shaft grounding rings shall be installed on all motors 5 hp and larger controlled by variable frequency drives.

3.3 INSTALLATION

A. Shaft grounding rings may be factory installed by the motor manufacturer or field installed. Field installations shall be in accordance with the shaft grounding ring manufacturer's written instructions for each specific motor.

END OF SECTION 230513

SECTION 230514

MOTOR CONTROLLERS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes ac motor-control devices for mechanical equipment rated 600 V and less that are supplied as enclosed units.

1.3 SUBMITTALS

A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Maintenance Data: For products to include in the maintenance manuals.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 150 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Field Testing Agency Qualifications: An independent testing agency with experience and capability to satisfactorily conduct testing indicated without delaying the Work. Evaluation criteria shall be according to ASTM E 699.

C. Source Limitations: Obtain similar motor-control devices through one source from a single manufacturer.

D. Comply with NFPA 70.

E. Listing and Labeling: Provide motor controllers specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.5 COORDINATION

A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, and the duty cycle of the motor and load.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses and Incandescent Indicating Lamps: Furnish 1 spare for every 5 installed units, but not less than 1 set of 3 of each kind.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Manual and Magnetic Motor Controllers:
   a. ABB
   b. Allen-Bradley Co.; Industrial Control Group.
   c. Cerus Industrial
   d. Cutler-Hammer Products.
   e. Danfoss Graham
   f. General Electric
   g. Siemens Energy & Automation, Inc.
   h. Square D.
2. Electronic Motor Controllers:
   a. ABB
   b. Allen-Bradley Co.; Industrial Control Group.
   c. Cutler-Hammer Products.
   d. Danfoss Graham
   e. Emerson
   f. General Electric
   g. Honeywell
   h. Siemens Energy & Automation, Inc.
   i. Square D.
   j. Yaskawa

2.2 MANUAL MOTOR CONTROLLERS

A. Description: NEMA ICS 2, general purpose, Class A with toggle action and overload element.

2.3 MAGNETIC MOTOR CONTROLLERS

A. Combination starters shall be furnished for all three phase motors, (unless specifically noted otherwise) and single-phase motors which are automatically started.

B. Starters shall be NEMA type and shall provide protection on all three phases.

C. Starters shall be magnetic across the line FVNR with "H-O-A" selector switch, red run pilot and fused disconnect.

D. Each starter shall have an individual control circuit transformer, line voltage primary, 120 volt secondary, with one fuse in the ungrounded side of the secondary. The transformer shall have 100% space capacity. Where electrical interlocking is involved, a separate contact on the circuit breaker disconnect shall open the interlock circuit. All sources of power to each combination starter shall be deenergized when the lockable circuit breaker disconnect is opened.

E. Starters for single phase motors not automatically started shall be manual type with thermal protection.

2.4 VARIABLE FREQUENCY CONTROLLERS (VARIABLE FREQUENCY DRIVES)

A. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide

self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

B. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Ambient Temperature Rating: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
6. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
7. Humidity Rating: Less than 95 percent (noncondensing).
8. Altitude Rating: Not exceeding 3300 feet (1005 m).
9. Vibration Withstand: Comply with IEC 60068-2-6.
10. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
11. Speed Regulation: Plus or minus 5percent.
12. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

D. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

E. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.

5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable dead-bands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Auto-speed Search" feature is available and engaged.

I. Bidirectional Auto-speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

J. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

L. Integral Input Disconnecting Means and OCPD: NEMA AB 1, circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFD input current rating.

M. Controls and Indication:

1. Status Lights: Door-mounted LED indicators displaying the following conditions:
   a. Power on
   b. Run
   c. Overvoltage
   d. Line fault
   e. Overcurrent
   f. External fault
2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      1) Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
3. Historical Logging Information and Displays:
   a. Real-time clock with current time and date.

b. Running log of total power versus time.
c. Total run time
d. Fault log, maintaining last four faults with time and date stamp for each.

4. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
   a. Output frequency (Hz)
   b. Motor speed (rpm)
   c. Motor status (running, stop, fault)
   d. Motor current (amperes)
   e. Motor torque (percent)
   f. Fault or alarming status (code)
   g. PID feedback signal (percent)
   h. DC-link voltage (V dc)
   i. Set point frequency (Hz)
   j. Motor output voltage (V ac)
5. Control Signal Interfaces:
   a. Electric Input Signal Interface:
      1) A minimum of two programmable analog inputs.
      2) A minimum of six multifunction programmable digital inputs.
   b. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
      1) to 10-V dc.
      2) 4- to 20-mA dc
      3) Potentiometer using up/down digital inputs
      4) Fixed frequencies using digital inputs.
   c. Output Signal Interface: A minimum of one programmable analog output signal which can be configured for any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (V dc).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set point frequency (Hz).
6. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.
   a. Network Communications Ports: Ethernet.
   b. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.

N. Line Conditioning and Filtering:

1. Output Filtering: Furnish DVDT filter where power wiring between VFD and motor exceeds 50 feet in length.

O. Normally if the separation between motor and VFC is less than 100 feet (30 m), the motor is designed for use with VFC, low carrier frequencies are specified, or all three, then output filtering may not be an issue. However, if distances are over 100 feet (30 m) and high carrier frequencies are being used, controller output voltage can exceed motor pulse-withstand capability. Consult motor and VFC manufacturers to determine need for, and options available for, conditioning output voltage. Options may include line inductors, dV/dT filters, output reactors, and motor termination filters. Insert requirements in first paragraph below. See "Motor and VFC Compatibility" Article in the Evaluations for additional guidance.

P. Bypass Systems:

1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
2. Bypass Mode: Manual operation only; requires local operator selection at VFD. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
3. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
   a. Bypass Contactor: Load-break, NEMA-rated contactor.
   b. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
4. Bypass Contactor Configuration: Full-voltage (across-the-line)type.
   a. NORMAL/BYPASS selector switch.
   b. HAND/OFF/AUTO selector switch.
   c. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
   d. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
      1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
      2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   e. Control Circuits: Obtained from integral CPT, with primary and secondary fuses with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
   f. Overload Relays: NEMA ICS 2.
      1) Melting-Alloy Overload Relays:
         i. Inverse-time-current characteristic.
         ii. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2.5 ENCLOSURES

A. Description: Flush or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, ventilated weatherproof enclosure.

2.6 ACCESSORIES

A. Devices are factory installed in controller enclosure, unless otherwise indicated.

B. Pilot Lights and "Hand-Off-Auto" Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break push-button station with a factory-applied hasp arranged so a padlock can be used to lock push button in depressed position with control circuit open.

D. Factory mounted with Nationally Recognized Testing Laboratory listed and labeled mounting device.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

D. Hand-Off-Automatic Selector Switches: In covers of controllers of motors started and stopped by automatic controls or interlocked with other equipment. Also, furnish "run" light in cover.

3.2 INSTALLATION

A. Install independently mounted motor-control devices according to manufacturer's written instructions.

B. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components, including the pretesting and adjustment of solid-state controllers.

C. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

D. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Division 26 Section.

E. Motor-Controller Fuses: Install indicated fuses in each fusible switch.

3.3 IDENTIFICATION

A. Identify motor-control components and control wiring according to Division 23 Sections.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 26.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic control devices where available.

1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, fire-related cutouts and motor overload protectors.

3.5 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, 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.

3.6 PROGRAMMING

A. Coordinate all programming of variable frequency drives between the drive manufacturer and the control system provider. Furnish all interface devices as required to affect communication between the VFD and the control system.

B. VFD programming shall include the coordination of operational speed ranges with those allowed by the manufacturer of the drive equipment.

1. VFD shall not drive equipment such that it operates at critical frequencies (harmonics.)
2. VFD shall not drive equipment at speeds which do not provide for proper cooling or lubricant circulation.

3.7 FIELD QUALITY CONTROL

A. Testing: After installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
2. Remove and replace malfunctioning units with new units, and retest.

3.8 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

3.9 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to demonstrate solid-state and variable- speed controllers and train Owner's maintenance personnel.

1. Conduct a minimum of 4 hours of training in operation and maintenance. Include training relating to equipment operation and maintenance procedures.
2. Schedule training with at least 7 days' advance notice.

END OF SECTION 230514

SECTION 230519

METERS AND GAGES FOR HVAC PIPING AND DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes meters and gages used in mechanical systems.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

C. Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

D. Maintenance data to be included in the "Operating and Maintenance Manuals." Include data for the following:

1. Test plugs.

1.4 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

B. Design Criteria: The Drawings indicate types, sizes, capacities, ranges, profiles, connections, and dimensional requirements of meters and gages and are based on the specific manufacturer types and models indicated. Meters and gages having equal performance characteristics by other manufacturers may be considered, provided that deviations do not change the design concept or intended performance as judged by the Design Professional. The burden of proof for equality of meters and gages is on the proposer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Liquid-in-Glass Thermometers:
   a. Miljoco Corp.
   b. Palmer-Wahl Instruments, Inc.
   c. H.O. Trerice Co.
   d. Weiss Instruments, Inc.
   e. Weksler Instruments Corp.

2. Pressure Gages:
   a. Ashcroft by Dresser Industries, Instrument Div.
   b. Marsh Instrument Co.
   c. H.O. Trerice Co.
   d. Weiss Instruments, Inc.
   e. Weksler Instruments Corp.
3. Test Plugs:
   a. Flow Design, Inc.
   b. MG Piping Products Co.
   c. Peterson Equipment Co., Inc.
   d. Sisco Co., Spedco, Inc.
   e. H.O. Trerice Co.
   f. Watts Regulator Co.

2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed as follows:

1. Heating Water: 30 to 300 deg F, with 2-degree scale divisions.
2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.

B. Accuracy: Plus-or-minus 1-percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Description: ASTM E 1, liquid-in-glass thermometer.

B. Case: Die-cast aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red-reading, organic liquid-filled with magnifying lens.

E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.

F. Stem: Copper-plated, steel, aluminum, or brass for a separable socket of length to suit installation.

2.4 PRESSURE GAGES

A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage, with bottom connection.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch -diameter glass lens.

C. Connector: Brass, 1/4-inch.

D. Scale: White-coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Fluids Under Pressure: 2 times operating pressure.

2.5 PRESSURE-GAGE ACCESSORIES

A. Syphons: 1/4-inch straight coil of brass tubing with threads on each end.

B. Snubbers: 1/4-inch brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.6 TEST PLUGS

A. Description: Nickel-plated brass-body test plug in 1/2-inch fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: 2 self-sealing valve types, suitable for inserting a 1/8-inch outside-diameter probe from a dial thermometer or pressure gage.

E. Core Material: According to the following for fluid and temperature range:

1. Air and Water: Minus 30 deg to 275 deg F, ethylene-propylene-diene-terpolymer (EPDM) rubber.

F. Test-Plug Cap: Gasketed and threaded cap, with retention chain.

G. Test Kit: Provide test kit consisting of 1 pressure gage and gage adapter with probe, 1 bimetal dial thermometer and a carrying case.

H. Pressure Gage and Thermometer Ranges: Approximately 2 times systems operating conditions.

PART 3 - EXECUTION

3.1 METER AND GAGE APPLICATIONS

A. General: Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.

3.2 METER AND GAGE INSTALLATION, GENERAL

A. Install meters, gages, and accessories according to manufacturers' written instructions for applications where used.

3.3 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions. Install in the locations indicated on the drawings and as noted below.

B. Install in the following locations and elsewhere as indicated:

1. At inlet and outlet of each hydronic boiler and chiller.
2. At inlet and outlet of each hydronic coil in air-handling.

C. Thermometer Wells: Install in vertical position in piping tees where thermometers are indicated.

1. Install wells with stem extending to center of pipe.
2. Fill wells with oil or graphite and secure caps.

3.4 PRESSURE GAGE INSTALLATION

A. Install pressure gages in piping tee with pressure gage valve located on pipe at most readable position. Install in locations indicated on the drawings and as noted below.

B. Install in the following locations and elsewhere as indicated:

1. At suction and discharge of each pump.
2. At chilled water inlets and outlets of chillers.
3. At inlets and outlets of boilers.

C. Pressure Gage Needle Valves: Install in piping tee with snubber. Install syphon instead of snubber for steam pressure gages.

3.5 TEST PLUG INSTALLATION

A. Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

3.6 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install meters and gages adjacent to machines and equipment to allow servicing and maintenance.

3.7 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

C. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 230519

SECTION 230523

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes general duty valves common to several mechanical piping systems.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

C. Maintenance data for valves to include in the operation and maintenance manual. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

B. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set globe and gate valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Valve Co.
2. Hammond Valve Corporation.
3. Apollo/Conbraco Ind. Inc.
4. Jomar Valve
5. Lunkenheimer/Cincinnati Valve Co.
6. Milwaukee Valve Company, Inc.
7. Nexus
8. Nibco Inc.
9. Powell Valves
10. Red-White Valve Corp.
11. Victaulic (grooved piping applications.)

2.2 BASIC, COMMON FEATURES

A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.

1. Non-rising stem valves may be used only where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated. All valves shall be a full port design.

D. Operators: Use specified operators and handwheels, except provide the following special operator features:

1. Handwheels: For valves other than quarter turn.
2. Lever Handles: For quarter-turn valves 6 inches and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
3. Chain-Wheel Operators: For valves 4 inches and larger, installed 96 inches or higher above finished floor elevation.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. Threads: ASME B1.20.1.

G. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

H. Solder Joint: ASME B16.18.

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.3 GATE VALVES

A. Gate Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi cold working pressure (CWP), or Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, copper-silicon alloy rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

B. Gate Valves, 3 Inches and Larger: MSS SP-70, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron handwheel.

2.4 BALL VALVES

A. Ball Valves, 4 Inches and Smaller: MSS SP-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction with threaded packing gland on the valve stem seal; chrome-plated brass ball, full port; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

1. Operator: Vinyl-covered steel lever handle.
2. Stem Extension: For valves installed in insulated piping.
3. Memory Stop: For operator handles.

2.5 PLUG VALVES

A. Plug Valves: MSS SP-78, 175-psi CWP, ASTM A 126 cast-iron body and bonnet, cast-iron plug, Buna N, Viton, or teflon packing, flanged or grooved end connections:

1. Operator: Lever.

2.6 GLOBE VALVES

A. Globe Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and screwed bonnet, rubber, bronze, or teflon disc, silicon bronze-alloy stem, teflon-impregnated packing with bronze nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

B. Globe Valves, 3 Inches and Larger: MSS SP-85, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted bonnet with bronze fittings, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

2.7 BUTTERFLY VALVES

A. Butterfly Valves: MSS SP-67, 200-psi CWP, 150-psi maximum pressure differential, ASTM A 126 cast-iron body and bonnet (or ductile iron body and bonnet), extended neck, stainless-steel stem, field-replaceable EPDM sleeve and stem seals, wafer, lug, or grooved style:

1. Disc Type: Aluminum bronze.
2. Operator for Sizes 2 Inches to 6 Inches: Lever handle with latch lock.

2.8 CHECK VALVES

A. Swing Check Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:

B. Swing Check Valves, 3 Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stems at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. For chain-wheel operators, extend chains to 60 inches above finished floor elevation.

H. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.

3.3 SOLDERED CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and globe valves to fully open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.4 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.6 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-1/2 Inches and Smaller: Solder ends or threaded ends.
2. Steel Pipe Sizes, 2-1/2 Inches and Smaller: Threaded end.
3. Steel Pipe Sizes, 3 Inches and Larger: Flanged end.

3.7 APPLICATION SCHEDULE

A. General Application: Use gate, ball, and butterfly valves (as indicated) for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Heating Water Systems: Use the following valve types:

1. Gate Valves: Class 150, bronze or cast-iron body to suit piping system.
2. Ball Valves: Class 150, 600-psi CWP, with stem extension and memory stop.
3. Plug Valves: Viton or teflon packing.
4. Globe Valves: Class 150, bronze or cast-iron body to suit piping system, and bronze disc.
5. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or epoxy-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
6. Bronze Swing Check: Class 150, with composition seat.
7. Check Valves: Iron swing, wafer, or lift type, as indicated. Swing check shall be Class 150 with bronze seat ring.

C. Chilled-Water Systems: Use the following valve types:

1. Gate Valves: Class 150, bronze body; or Class 125, cast-iron body.
2. Ball Valves: Class 150, 600-psi CWP, with stem extension and memory stop.
3. Plug Valves: Buna N packing.
4. Globe Valves: Class 125, bronze body with bronze or teflon disc; or Class 125, cast-iron body.
5. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM sleeve and stem seals.
6. Check Valves: Class 125, bronze body swing check with rubber seat; Class 125, cast-iron body swing check; Class 125, cast-iron body wafer check; or Class 125, cast-iron body lift check.

3.8 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 230523

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical systems piping and equipment.

1.3 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

1.4 PERFORMANCE REQUIREMENTS

A. Design seismic restraint hangers and supports, for piping and equipment.

B. Design and obtain approval from authority with jurisdiction over seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for each type of hanger and support.

C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

1.6 QUALITY ASSURANCE

A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code--Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

C. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.

D. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

E. Licensed Engineer: Prepare hanger and support design drawings, and calculations for seismic restraint of piping and equipment. Include seal and signature of Registered Engineer, licensed in jurisdiction where Project is located, certifying compliance with specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.

1. Components include galvanized coatings or alternate rust preventing shop coating.
2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

C. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

D. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

2.2 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, steel plates, shapes, and bars, black and galvanized.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Grout: ASTM C 1107, Grade B, non-shrink, nonmetallic.

1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Water: Potable.
4. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in the Section specifying the equipment and systems.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.

C. Install supports with maximum spacings complying with MSS SP-69.

D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

E. Install building attachments within concrete or structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at 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 to forms. Install reinforcing bars through openings at top of inserts.

F. Install concrete inserts in new construction prior to placing concrete.

G. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated Tool Manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

H. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

K. Support all piping direct from structure and independent of other piping.

L. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

M. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.

O. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
3. Shields: Install MSS Type 40, protective shields on insulated piping. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

NPS (Inches)	LENGTH T (Inches)	HICKNESS (Inches)
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105

4. Pipes 6 Inches and Larger: Include shield inserts.
5. Insert Material: Length at least as long as the protective shield.
6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

B. Grouting: Place grout under supports for equipment and make a smooth bearing surface.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without under-cut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

C. Paint all exposed steel surfaces with one coat of primer and two coats of enamel.

END OF SECTION 230529

SECTION 230548

VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes vibration isolators, vibration isolation bases and vibration isolation roof curbs.

1.3 SUBMITTALS

A. Product Data: Indicate types, styles, materials, and finishes for each type of isolator specified. Include load deflection curves.

1.4 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases that are similar to those indicated for this Project in material, design, and extent.

B. The manufacturer and/or his representative shall select all vibration isolation products in accordance with the Vibration Isolation Schedule listed in these specifications. All products shall provide the specified deflection as indicated based on the actual equipment weights and installation requirements of the approved equipment. The manufacturer shall provide installation instructions for all provided isolators and seismic restraints and bracing. Locations of vibration isolation products shall be coordinated with equipment details shown on the drawings and also as specified in these specifications for maximum support locations for piping and other equipment.

C. All isolation deflections shall be based on ASHRAE 2019 Handbook - HVAC Applications, Chapter 49. The isolation of any mechanical equipment included in these plans that is not specifically covered by these specifications shall be isolated in accordance with Chapter 49, Table 47 as described above.

1.5 COORDINATION

A. Coordinate layout and installation of vibration isolation devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of concrete housekeeping and vibration isolation bases. Cast anchor-bolt inserts into base.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kinetics Noise Control, Inc. (basis of design)
2. Amber/Booth Company, Inc.
3. Vibration Mountings and Controls
4. Mason Industries
5. Vibration Eliminator

2.2 ISOLATOR TYPES

A. Type 2, Floor Mounted Equipment (non-seismic):

1. Vibration isolators shall be neoprene, molded from oil-resistant compounds. Isolators shall consist of two layers of neoprene material. Top and bottom surfaces of each layer shall have molded ribs. Each layer shall be separated by a 16-gauge galvanized steel load plate bonded to each neoprene layer to form a sandwich arrangement. Vibration isolator size shall be coordinated with the equipment supports. Minimum size shall be 2”x2”.
2. Isolators shall be equal to Kinetics Model NPD.

B. Type 4, Floor-Mounted Equipment (non seismic):

1. Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as indicated on the project documents. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with steel leveling bolt lock nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
2. Isolators shall be equal to Kinetics Model FDS

C. Type 5, Floor Mounted Equipment (seismic):

1. Vibration isolators shall be seismically rated and consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment and the horizontal movement.
2. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure.
3. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity.
4. Isolator shall be designed to allow replacement of the spring element without removing the spring isolator housing.
5. Vibration isolators shall be equal to Kinetics Model FHS.

D. Type 10, Suspended Equipment, Piping, Ductwork:

1. Vibration Isolators shall consist of a steel spring and neoprene element in series mounted in a stamped or welded steel bracket for insertion into the hanger rod assembly.
2. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range.

3. The steel spring shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity.
4. The steel bracket shall be fabricated from steel and provided with a corrosion resistance finished. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit. The hanger bracket shall incorporate spring caps with indexed steps, which correspond to the washer diameter of the hanger rod to keep the rod centered in the spring cap.
5. Vibration isolation hangers shall be equal to Kinetics Model SRH

2.3 BASES, RAILS AND CURBS

A. Type C, Roof Mounted Equipment Vibration Isolation Rails:

1. Vibration isolation rails shall consist of an extruded aluminum lower support rail, extruded aluminum upper support rail, steel springs located between the support rail and a continuous weatherproof seal located between the upper and lower support rails.
2. Vibration isolation rails shall be fabricated and designed to be installed and secured on top of the standard manufacturers seismically rated roof curb furnished with the equipment or a Type E roof curb as hereinafter specified.
3. Isolation rails shall provide continuous support for the roof-mounted equipment.
4. Isolation rails shall be designed and engineered to provide isolation against casing radiated vibration and structure born vibration from rotating equipment.
5. The steel springs shall consist of large diameter laterally stable steel springs that have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity.
6. Isolation rails shall have seismic restraints fabricated and attached to the isolation rail assembly to resist the horizontal forces. Seismic restraints shall be certified by the manufacturer and stamped by a registered engineer.
7. Isolation rail assemblies shall include supply and return duct block-outs as an integral part of the isolation rail assembly.
8. Isolation rails shall be equal to Kinetics Model KSR.

B. Type D, Roof Mounted Vibration Isolation Curbs:

1. All roof top air conditioning units shall be mounted and installed on vibration isolation curbs. The vibration isolation curbs shall be a complete assembly designed to resiliently support the equipment with a minimum operating height of 21” and shall be fully enclosed and weather tight.
2. The isolation curb shall consist of an upper support rail with supply and return air duct supports and a lower support curb that is attached to the supporting roof structure. The upper and lower supports shall be separated by free- standing un-housed, laterally stable spring isolators. Access ports shall be provided in the curb to access spring isolators.
3. The upper support rail shall be fabricated from a structural channel with sufficient elevation above the springs to preclude interference with the rooftop equipment and permit access to inspect the spring isolators.
4. The lower support curb shall be a formed galvanized steel channel with a 1 2“ wood nailer around the perimeter of the supporting upper rail. The lower support curb shall be a minimum of 14” high.
5. An ozone and UV resistant weather seal shall be installed between the upper and lower supports to provide a weatherproof installation.

6. Spring isolators shall be selected to provide 1" deflection for the equipment installed. Steel springs shall be free standing, un-housed, laterally stable. Springs shall have a minimum lateral stiffness of 1.2 times the rated vertical stiffness and shall be designed for a 50% overload to solid height.
7. Curb shall be insulated with a minimum of 1" fiberglass insulation.
8. Curb shall be engineered and certified to meet the seismic requirements of the location installed. A licensed registered engineer shall stamp curb design and engineering calculations to show compliance to the International Building Code.
9. Curbs shall be equal to Kinetics Model ESR.

2.4 SOUND CONTROL PRODUCTS

A. Acoustical Sound Barrier:

1. Acoustical sound barrier material shall be installed within the curb area of all roof-mounted air handling units.
2. Barrier material shall be constructed of a vinyl material with a reinforced fiberglass screen loaded with barium sulfate, 1.0 lb per square foot. Tensile strength shall be 300 lbs per inch and tear strength shall be 100 lbs per in.
3. Install 2 layers of acoustical barrier material inside the roof curb. Barrier material shall be cut, and uniform installed inside the curb area on top of the metal roof deck and around the supply and return air ducts.
4. Barrier material shall be equal to Kinetics KNM-100 RB.

B. Acoustical Duct Wrap Barrier:

1. Acoustic duct wrap barrier shall be fabricated of a composite material consisting of an acoustic barrier material bonded to a thin layer of aluminum foil on one side and a decoupling layer of fiberglass batting material.
2. Acoustic barrier shall be constructed of 0.10" thick barium sulphate loaded limp vinyl.
3. Barrier material shall have a "K" value of 0.29, STC rating of 31.
4. Fire Test per ASTM E84-15b: Flame Spread – 25; Smoke Developed – 450; Class A.
5. Barrier material shall have a nominal density of 1 psf.
6. Barrier material shall be equal to Kinetics KNM-200AL.

PART 3 - EXECUTION

3.1 INSTALLATION

A. If the equipment provided is not furnished with integral structural steel supports, mounting feet or lifting lugs, the contractor shall provide miscellaneous steel shapes as required to install or suspend the equipment and attach the vibration isolation devices as specified herein.

B. Support steel shall include but not be limited to rails, brackets, angles, channels, and similar components.

C. All equipment specified to be isolated shall be installed and isolators shall be attached to the building structure or floor and the vibration isolators shall be adjusted and leveled so that the vibration isolators are performing properly.

D. All vibration isolation products, flexible pipe connectors and sound control products shall be installed as outlined in the manufacturer's printed installation instructions.

E. Install pipe isolation connectors at connections for equipment supported on vibration isolators. Install isolation hangers on the first three piping supports adjacent to vibration producing equipment (i.e. air handling units, pumps, etc.).

3.2 VIBRATION ISOLATION CERTIFICATE OF COMPLIANCE

A. The manufacturer's representative shall be responsible for providing such assistance and supervision as necessary to assure a correct installation and adjustment of vibration isolation products.

B. The manufacturer's representative shall visit the installation once all installed items have been completed but prior to the installation of ceilings or walls that may conceal any devices and inspect the installation for compliance with the manufacturer's installation instructions. Upon satisfaction that all devices are installed correctly, and systems are isolated properly, the representative shall submit a written report outlining the installation as in compliance with these specifications and the manufacturer's installation instructions.

3.3 VIBRATION ISOLATION SCHEDULE FOR MECHANICAL SYSTEMS

Equipment Type	Isolator	Base	Deflection
Air Cooled Chillers	Type 2	None	0.25"
Piping located in Mechanical Rms.	Type 10	None	1.0"
Roof Mounted Air Handing Units	Type 4	Type D	1.0"
Roof Mounted Power Ventilators (except fans used in grease-hood applications)	Type 4	Type C	1.0"
Roof Mounted Condensing Units	Type 5	Equip. Rails	1.0"

END OF SECTION 230548

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SECTION 230593

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Measuring sound and vibration.
7. Reporting results of the activities and procedures specified in this Section.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. AABC: Associated Air Balance Council.

N. AMCA: Air Movement and Control Association.

O. CTI: Cooling Tower Institute.

P. NEBB: National Environmental Balancing Bureau.

Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

D. Certified Testing, Adjusting, and Balancing Reports: Submit reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

E. Sample Report Forms: Submit 3 sets of sample testing, adjusting, and balancing report forms.

F. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
3. Certify that the Agent has either tested and balanced systems according to the Contract Documents or that systems are balanced to optimum performance capabilities within design and installation limits.

C. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

D. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

E. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

F. Test and balance process is not deemed as accepted until a complete report is received free of deficiencies and discrepancies and approved in writing by the Engineer.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

B. Phasing: Project to be constructed in multiple phases, each potentially required TAB work. Coordinate phasing with General Contractor.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Furnish one of the following special warranties:

1. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents.
2. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine project record documents.

D. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Review manufacturer’s certification for each piece of HVAC equipment to be tested. Test and balance shall not be performed until certification letters have been obtained.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible, and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine equipment for installation and for properly operating safety interlocks and controls.

P. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
5. Thermostats and sensors are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

Q. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or AABC National Standards and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume, multizone, dual-duct, induction-unit supply-air systems and process exhaust-air systems. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
2. Measure static pressure across each air-handling unit component.
    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Measure static pressures entering and leaving other devices such as duct silencers under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Adjust fan speed higher or lower than design with the approval of the Design Professional. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
   a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using standard measurement practices.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

F. Measure outdoor air flow minimum requirement damper settings as scheduled with controls contractor. Document voltage settings of control damper actuator in the minimum cfm position. For units with demand control ventilation, measure outdoor air flow maximum requirement settings as scheduled with controls contractor. Document voltage setting of control damper actuator in the maximum cfm position. Controls contractor shall provide on-site technical support to modulate outside air damper min/max position with test and balance contractor to accomplish min/max cfm settings for proper unit operation.

3.7 VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES

A. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at a minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
3. Measure total system airflow. Adjust to within 10 percent of design airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

3.8 BI-POLAR IONIZATION UNITS

A. Confirm operation of bi-polar ionization units, where installed, using a voltage detector or other means to determine the presence of ions in the airstream. Report any nonconforming units.

3.9 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at design flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.10 HYDRONIC SYSTEMS' BALANCING PROCEDURES

A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves at calculated pre-settings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.

E. Adjust balancing stations to within specified tolerances of design flow rate as follows:

1. Determine the balancing station with the highest percentage over design flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.11 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.12 PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance the primary system crossover flow first, then balance the secondary system.

3.13 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Speed Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.14 CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of design flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator water entering and leaving temperatures, pressure drop, and water flow.
2. Condenser water entering and leaving temperatures, pressure drop, and water flow.

3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by the chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kW.
5. The kW input if factory-installed instrumentation is furnished for measuring kW.
6. Capacity: Calculate in tons of cooling.
7. Air-Cooled Chillers: Verify condenser-fan rotation and record fan data, including number of fans and entering- and leaving-air temperatures.

3.15 CONDENSING UNITS

A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

3.16 BOILERS

A. Measure entering- and leaving-water temperatures and water flow.

3.17 HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperatures.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperatures of entering and leaving air.
5. Wet-bulb temperatures of entering and leaving air (for cooling coils).
6. Airflow.
7. Air pressure drop.

B. Dx Coils: Measure the following data for each coil:

1. Dry-bulb temperatures of entering and leaving air.
2. Wet-bulb temperatures of entering and leaving air (for cooling coils).
3. Airflow.
4. Air pressure drop.

3.18 TEMPERATURE TESTING

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.19 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Record voltages of power supply and controller output. Determine if the system operates on a grounded or non-grounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.20 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: Minus 10 percent to plus 10 percent.
    a. In spaces that are to have positive pressure relationship to adjacent spaces, the overall space tolerances for supply airflow shall be 0 to plus 10 percent and return/exhaust airflow shall be 0 to minus 10 percent.
    b. In spaces that are to have a negative pressure relationship to adjacent spaces, the overall space tolerances for supply airflow shall be 0 to minus 10 percent and return/exhaust airflow shall be 0 to plus 10 percent.
3. Heating-Water Flow Rate: Minus 10 percent to plus 10 percent.
4. Cooling-Water Flow Rate: 0 to plus 10 percent.

3.21 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.22 FINAL REPORT

A. General: Electronic (PDF) format, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of document signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.
2. Include letters from HVAC equipment manufacturers certifying that each piece of equipment has been installed and commissioned in accordance with manufacturer’s recommendations.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

3.23 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: Perform testing, adjusting, and balancing procedures during near-peak summer (above 85ºF) and during near-peak winter conditions (below 40ºF.) Retainage may be held until each season has been tested. Refer to contract documents.

END OF SECTION 230593

SECTION 230700

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes pipe, duct, and equipment insulation.

1.3 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 deg F.

D. Thermal resistivity is designated by an R-value that represents the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivity (R-value) is expressed by the temperature difference in degrees Fahrenheit between the two exposed faces required to cause 1 BTU per hour to flow through 1 square foot at mean temperatures indicated.

E. Thermal Conductivity (k-value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of Btu x inch/h x sq. ft. x deg F.

F. Density: Is expressed in lb./cu.ft.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract.

B. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories. Provide a summary in schedule form of intended insulation material, jacket type, thickness and adhesive type for each pipe, duct or equipment using manufacturer's nomenclature.

1.5 QUALITY ASSURANCE

A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

1.6 SEQUENCING AND SCHEDULING

A. Schedule insulation application after testing of piping and duct systems.

B. Schedule insulation application after installation and testing of heat trace tape.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Glass Fiber:
   a. CertainTeed Corporation
   b. Knauf Fiberglass GmbH
   c. Manville
   d. Owens-Corning Fiberglas Corporation
   e. USG Interiors, Inc. - Thermafiber Division
2. Cellular Glass:
   a. Pittsburgh Corning Corporation
   b. Cell-U-Foam Insulation
   c. Manville
3. Flexible Elastomeric Cellular:
   a. Armaflex; Armacell LLC
   b. K-Flex; Nomaco K-Flex Corporation
   c. Aerocel; Aeroflex USA, Inc.

2.2 GLASS FIBER

A. Material: Inorganic glass fibers, bonded with a thermosetting resin.

B. Jacket: All-purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.

C. Board: ASTM C 612, Class 2, semi-rigid jacketed board.

1. Thermal Conductivity: 0.26 Btu x inch/h x sq. ft. x deg F average maximum, at 75 deg F mean temperature.
2. Density: 3 pcf minimum.

D. Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets.

1. Thermal Conductivity: 0.32 Btu x inch/h x sq. ft. x deg F average maximum, at 75 deg F mean temperature.
2. Density: 3/4 pcf minimum within building envelope.
3. Density: 1 pcf minimum exterior to building envelope.

E. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, jacketed.

1. Thermal Conductivity: 0.26 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F mean temperature.
2. Density: 3 pcf minimum.

F. Adhesive: Produced under the UL Classification and Follow-up service.

1. Type: Non-flammable - solvent-based.
2. Service Temperature Range: Minus 20 to 180 deg F.

G. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.3 CELLULAR GLASS

A. Material: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.

B. Facing: ASTM C 921, Type 1, factory-applied, laminated foil, flame-retardant, vinyl facing.

C. Form: The following as indicated:

1. Blocks: ASTM C 552, Type I.

2. Boards: ASTM C 552, Type IV.
3. Preformed Pipe: ASTM C 552, Type II, Class 2 (jacketed).
4. Special Shapes: ASTM C 552, Type III, in shapes and thicknesses as indicated.

D. Thermal Conductivity: 0.38 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F mean temperature.

E. Minimum Density: 7 pcf.

F. Maximum Density: 9.5 pcf.

2.4 FLEXIBLE ELASTOMERIC CELLULAR

A. Material: Flexible expanded closed-cell structure with smooth skin on both sides.

1. Tubular Materials: ASTM C 534, Type I.
2. Sheet Materials: ASTM C 534, Type II.

B. Thermal Conductivity: 0.25 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F.

C. Coating: Water based latex enamel coating recommended by insulation manufacturer.

D. Fire Performance Characteristics: Provide material having the following fire performance characteristics as determined by UL in accordance with ASTM Standard E84:

1. Flame Spread = 25
2. Smoke Developed = 50

2.5 INSULATING CEMENTS

A. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: ASTM C 449.

B. Thermal Conductivity: 1.2 Btu x inch/h x sq. ft. x deg F average maximum at 400 deg F mean temperature.

C. Compressive Strength: 100 psi at 5 percent deformation.

2.6 ADHESIVES

A. Flexible Elastomeric Cellular Insulation Adhesive: Solvent-based, contact adhesive recommended by insulation manufacturer.

B. Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:

1. Class 1, Grade A for bonding glass cloth and tape to unfaced glass fiber insulation, sealing edges of glass fiber insulation, and bonding lagging cloth to unfaced glass fiber insulation.
2. Class 2, Grade A for bonding glass fiber insulation to metal surfaces.

2.7 JACKETS

A. General: ASTM C 921, Type 1, except as otherwise indicated.

B. Foil and Paper Jacket: Laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

1. Water Vapor Permeance: 0.02 perm maximum, when tested according to ASTM E 96.
2. Puncture Resistance: 50 beach units minimum, when tested according to ASTM D 781.

C. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20 mil thick, high-impact, ultra-violet-resistant PVC.

1. Adhesive: As recommended by insulation manufacturer.

D. Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, roll stock ready for shop or field cutting and forming to indicated sizes.

1. Finish and Thickness: Stucco embossed finish, 0.016 inch thick.
2. Moisture Barrier: 3 mil Dupont Surlyn.
3. Elbows: Preformed 45-degree and 90-degree, short- and long-radius elbows, same material, finish, and thickness as jacket.

2.8 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, pre-sized a minimum of 8 ounces per sq. yd.

1. Tape Width: 3 inches.
2. Cloth Standard: MIL-C-20079H, Type I.
3. Tape Standard: MIL-C-20079H, Type II.

B. Bands: ¾-inch wide, in one of the following materials compatible with jacket:

1. Galvanized Steel: 0.005 inch thick.
2. Aluminum: 0.007 inch thick.

C. Glass Fiber Reinforcing Mesh (Glassfab): High-strength, open weave, resin-treated, fiberglass reinforcing reinforcement of coatings.

1. 10 strands x 10 strands per sq. in.
2. Minimum 1.8 ounces per sq. yd.

D. Wire: 14 gage nickel copper alloy, 16 gage, soft-annealed stainless steel, or 16 gage, soft-annealed galvanized steel.

E. Corner Angles: 28-gage, 1-inch by 1-inch aluminum, adhered to 2-inches by 2-inches kraft paper.

F. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

2.9 SEALING COMPOUNDS

A. Vapor Barrier Compound: Water-based, fire-resistive composition.

1. Water Vapor Permeance: 0.15 perm maximum.
2. Temperature Range: Minus 20 to 180 deg F.

B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.

1. Water Vapor Permeance: 0.02 perm maximum.
2. Temperature Range: Minus 50 to 250 deg F.
3. Color: Aluminum.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

B. Mix insulating cement with clean potable water. Mix insulating cement contacting stainless-steel surfaces with demineralized water.

1. Follow cement manufacturer's printed instructions for mixing and portions.

3.2 INSTALLATION, GENERAL

A. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.

B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.

C. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 60 deg F.

D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45-degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

K. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:

1. Fibrous glass ducts.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
4. Flexible connectors for ducts and pipes.
5. Vibration control devices.
6. Testing laboratory labels and stamps.
7. Nameplates and data plates.
8. Pre-insulated access panels and doors in air distribution systems.

3.3 PIPE INSULATION INSTALLATION, GENERAL

A. Tightly butt longitudinal seams and end joints. Bond with adhesive.

B. Stagger joints on double layers of insulation.

C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.

D. Apply insulation with a minimum number of joints.

E. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Cover circumferential joints with butt strips, at least 3 inches wide, and of same material as insulation jacket. Secure with adhesive and outward clinching staples along both edges of butt strip and space 4 inches on center.
3. Longitudinal Seams: Overlap seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
   a. Exception: Do not staple longitudinal laps on insulation applied to piping systems with surface temperatures at or below 35 deg F.
4. Vapor Barrier Coatings: Where vapor barriers are indicated, apply on seams and joints, over staples, and at ends butt to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor barrier coating.

6. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Adhere, staple, and seal. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.

F. Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 2 inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.

G. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.

H. Wall and Partition Penetration: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions. Where materials transition due to differences in interior/exterior specifications, transition shall occur at exterior wall surface.

I. Fire-Rated Walls and Partitions Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with a U.L. Listed firestopping or fire-resistant joint sealer.

J. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.

K. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with vapor barrier coating. Apply pre-molded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive.

1. Use same material and thickness as adjacent pipe insulation.
2. Overlap nesting insulation by 2 inches or 1-pipe diameter, whichever is greater.
3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.
4. Insulate elbows and tees smaller than 3 inches pipe size with pre-molded insulation.
5. Insulate elbows and tees 3 inches and larger with pre-molded insulation or insulation material segments. Use at least 3 segments for each elbow.
6. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.

L. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. Install saddles, shields, and inserts as specified in Division 23 Section "Hangers and Supports."

3.4 BELOW GROUND PIPE INSULATION INSTALLATION

A. See individual piping sections.

3.5 GLASS FIBER PIPE INSULATION INSTALLATION

A. Bond insulation to pipe with lagging adhesive.

B. Seal exposed ends with lagging adhesive.

C. Seal seams and joints with vapor barrier compound.

3.6 CELLULAR GLASS PIPE INSULATION INSTALLATION

A. Cellular Glass Insulation: Join sections of cellular glass insulation with vapor barrier compound. Secure insulation with manufacturer's recommended adhesive. Seal joints with manufacturer's recommended joint sealer.

1. Multiple Layer Installations: Stagger joints of multilayer installations. Secure inner layer with glass fiber reinforced tape. Secure outer layers with 2 metal bands for each insulation section.
   a. Finishing: Apply manufacturer's recommended weather barrier mastic.
   b. Finishing: Apply metal jacket over manufacturer's recommended vapor barrier mastic.

3.7 FLEXIBLE ELASTOMERIC CELLULAR PIPE INSULATION INSTALLATION

A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, cut one side longitudinally and apply to the pipe. Seal seams and joints with adhesive.

B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive.

1. Miter cut materials to cover soldered elbows and tees.
2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

3.8 EQUIPMENT INSULATION INSTALLATION, GENERAL

A. Install board and block materials with a minimum dimension of 12 inches and a maximum dimension of 48 inches.

B. Groove and score insulation materials as required to fit as closely as possible to the equipment and to fit contours of equipment. Stagger end joints.

C. Insulation Thicknesses Greater than 2 Inches: Install insulation in multiple layers with staggered joints.

D. Bevel insulation edges for cylindrical surfaces for tight joint.

E. Secure sections of insulation in place with wire or bands spaced at 9 inches centers, except for flexible elastomeric cellular insulation.

F. Protect exposed corners with corner angles under wires and bands.

G. Manholes, Handholes, and Information Plates: Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

H. Removable Insulation: Install insulation on components that require periodic inspecting, cleaning, and repairing for easy removal and replacement without damage to adjacent insulation.

I. Pumps: Where insulation is indicated, fabricate galvanized steel boxes lined with insulation. Fit boxes around pumps and coincide joints in box with the splits in the pump casings. Fabricate joints with outward bolted flanges.

J. Finishing: Except for flexible elastomeric cellular insulation, apply 2 coats of vapor barrier compound to a minimum thickness of 1/16 inch. Install a layer of glass cloth embedded between layers.

3.11 GLASS FIBER EQUIPMENT INSULATION INSTALLATION

A. Secure insulation with anchor pins and speed washers.

B. Space anchors at maximum intervals of 18 inches in both directions and not more than 3 inches from edges and joints.

C. Apply a smoothing coat of insulating and finishing cement to finished insulation.

3.12 CELLULAR GLASS EQUIPMENT INSULATION INSTALLATION

A. Join sections of insulation with vapor barrier compound.

B. Secure insulation with manufacturer's recommended adhesive. Seal joints with manufacturer's recommended joint sealer.

C. Secure inner layer of multiple layer installations with glass fiber reinforced tape. Secure outer layers with 2 metal bands for each insulation section.

3.13 FLEXIBLE ELASTOMERIC CELLULAR EQUIPMENT INSULATION INSTALLATION

A. Install sheets of the largest manageable size.

B. Apply full coverage of adhesive to the surfaces of the equipment and to the insulation.

C. Butt insulation joints firmly together and apply adhesive to insulation edges at joints.

3.14 DUCT INSULATION

A. Install block and board insulation as follows:

1. Adhesive and Band Attachment: Secure block and board insulation tight and smooth with at least 50 percent coverage of adhesive. Install bands spaced 12 inches apart. Protect insulation under bands and at exterior corners with metal corner angles. Fill joints, seams, and chipped edges with vapor barrier compound.
2. Speed Washers Attachment: Secure insulation tight and smooth with speed washers and welded pins. Space anchor pins 18 inches apart each way and 3 inches from insulation joints. Apply vapor barrier coating compound to insulation in contact, open joints, breaks, punctures, and voids in insulation.

B. Blanket Insulation: Install tight and smooth. Secure to ducts having long sides or diameters as follows:

1. Smaller Than 24 Inches: Bonding adhesive applied in 6 inches wide transverse strips on 12 inches centers.
2. 24 Inches and Larger: Anchor pins spaced 12 inches apart each way. Apply bonding adhesive to prevent sagging of the insulation.
3. Overlap joints 3 inches.
4. Seal joints, breaks, and punctures with vapor barrier compound and glass tape (glasfab and mastic).

3.15 JACKETS

A. Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1-1/2 inches laps at longitudinal joints and 3-inch-wide butt strips at end joints.

1. Seal openings, punctures, and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound (mastic) and glass tape (glassfab).

B. Exterior Exposed Insulation: Install continuous aluminum jackets and seal all joints and seams with waterproof sealant.

C. Install metal jacket with 2 inches overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel draw bands 12 inches on center and at butt joints.

D. Install glass cloth jacket directly over insulation. On insulation with a factory applied jacket, install the glass cloth jacket over the factory applied jacket. Install jacket drawn smooth and tight with a 2-inch overlap at joints. Embed glass cloth between (2) 1/16inch thick coats of lagging adhesive. Completely encapsulate the insulation with the jacket, leaving no exposed raw insulation.

3.16 FINISHES

A. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply 2 coats of protective coating to exposed exterior insulation.

3.17 APPLICATIONS

A. General: Materials and thicknesses are specified in schedules at the end of this Section.

B. Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Chilled water.
2. Domestic makeup water piping.
3. Heating water.
4. Air conditioning condensate drains and sanitary P-traps receiving air conditioning condensate.
5. All refrigerant piping used for split systems with inverter-driven outdoor units (i.e. mini-splits, ductless split systems.)

C. Equipment: Unless otherwise indicated, insulate the following equipment:

1. Chilled water equipment, tanks, pumps, and heat exchangers.
2. Heating water equipment, tanks, pumps, and heat exchangers, 100 deg F to 250 deg F.
3. Boiler flues and breechings.

D. Duct Systems: Unless otherwise indicated, insulate the following duct systems:

1. Supply, return and outside air ductwork.
2. Above-ceiling surfaces of all air devices except where pre-insulated.
3. Interior exposed supply, return and outside air ductwork.
4. Exterior exposed supply and return ductwork.

3.18 PIPE INSULATION SCHEDULES

A. General: Furnish insulation vapor barrier on all piping carrying fluids below 60ºF.

B. Schedules:

1. Chilled Water Piping:
   a. 1-inch Cellular glass insulation for piping 1½-inches and smaller. 1½inch cellular glass insulation for piping 2-inches and larger.
   b. Furnish 2-inch insulation thickness for applications where piping is exposed above the roof.
   c. Furnish aluminum jacket on exterior piping.
2. Heating Water Piping:
   a. 1" rigid fiberglass insulation for piping 1" and smaller.
   b. 1-1/2" rigid fiberglass insulation for piping larger than 1".
   c. Furnish aluminum jacket on exterior piping.
3. All refrigerant piping used for split systems with inverter driven outdoor units (i.e. mini-splits, ductless split systems): 3/4” flexible elastomeric insulation. Paint exterior insulation with two coats of manufacturer’s recommended coating.
4. and Humidifier Drain Piping: 3/8" flexible elastomeric insulation (interior applications only).
5. Domestic Makeup Water Piping: ¾” flexible elastomeric insulation.

3.19 EQUIPMENT INSULATION SCHEDULES

A. General: Furnish insulation vapor barrier on all equipment with surface temperatures below 60º F.

B. Schedules:

1. Heating Water Equipment: 1" glass fiber block or board. Furnish aluminum jacket for exterior installations.
2. Chilled Water Equipment: 1" flexible elastomeric insulation. Furnish aluminum jacket for exterior installations.

3.20 DUCTWORK AND PLENUM INSULATION SCHEDULES

A. General: Furnish vapor barrier on all ductwork insulation.

B. Schedules:

1. Supply, return, and outdoor air ductwork:
   a. Lined and unlined within building insulation envelope: 2" glass fiber blanket. Seal all joints and penetrations in jacket with glasfab and mastic.
   b. Outside Building Insulation Envelope: 3” glass fiber blanket or board.
2. Exterior Supply and return, relief ductwork between air inlet devices and HVAC units and outdoor air ductwork (lined and unlined): 2” polyisocyanurate board with aluminum jacket.

3.21 INSULATION EXPOSED IN MECHANICAL ROOMS

A. Finish all piping, equipment and ductwork insulation exposed in each mechanical room with a field applied 8 ounce per square yard canvas jacket cemented in place with white lagging adhesive.

B. Apply PVC pipe fitting covers over canvas.

C. Paint canvas with two coats of enamel paint. Colors shall be approved by the Design Professional. Piping insulation shall be painted in accordance with the Owner’s color scheme.

END OF SECTION 230700

SECTION 230900

CONTROLS SYSTEM EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components.

1.3 SYSTEM DESCRIPTION

A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and direct digital controllers (DDC) operating in a high-speed, peer-to-peer network hosted by a Facility Management System (FMS) server running a webserver software application. System shall be programmed to operate mechanical systems according to sequences of operation indicated or specified.

B. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The FMS system server shall be accessed using Web browsers over the control system network, the Owner's local area network (LAN), and over the Internet (at the Owner’s discretion). Current web browsers shall be capable of accessing the web server including, Google Chrome, Mozilla Firefox, Apple Safari and Microsoft Edge. Contractor shall be responsible for coordination with the Owner’s IT staff to ensure that the FMS will perform in the Owner’s environment without disruption to any of the other activities taking place on the LAN.

C. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No additional software or applications shall be required to access graphic and point displays or configure trends, points and controllers. Computer and Mobile Device browsers shall be supported.

D. FMS contractor shall provide all control panels, power supplies, wiring, conduit, solenoid valves, relays, differential pressure transmitters, differential pressure switches, pressure sensors, interface devices, etc. necessary for a complete and operable automatic control system and for communication through the Owner’s LAN.

E. System shall use the BACnet protocol for communication to the FMS web server and for communication between control modules. I/O points, schedules, setpoints, trends, and alarms specified or on the drawings or identified in the "Sequence of Operation" shall be BACnet objects.

F. FMS server software shall be licensed to support not less than forty (40) browser users simultaneously. FMS server software shall allow a unique username, and password for each simultaneous user, and shall be configured to provide unique functionality limits for each of the forty (40) simultaneous users. No license or software shall be required on browser devices.

G. All new digital controls shall interface with the existing FMS server for this building/facility. Integrate new graphics pages into existing web interface in an intuitive manner. A hyperlink to another system software is not acceptable.

H. Provide and install the latest available updates for the existing webserver software application.

I. The FMS manufacturer's Software Tool(s) required to create, edit, and modify the FMS database, system graphics, system configuration, and sequences of operation, shall be provided as part of this contract. Provide software licenses (if required) for installation of these Software Tools on six (6) of the Owner's computers. Licenses shall be issued to the Owner, not the Contractor. Software licenses shall be paid in advance under this Contract for a minimum of five (5) years.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each type of product specified. Include manufacturer's technical Product Data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, and startup instructions.

C. Where equipment, controllers or sensors furnished as a part of other mechanical equipment are to be interlocked or interfaced with the control system (FMS) furnished under this section, provide documentation from the equipment manufacturer or supplier indicating all wiring and software requirements have been coordinated and accommodated. Provide references in the FMS diagrams and operational sequences indicating these accommodations. Where equipment controllers are integrated into the FMS via BACnet Protocol, provide the Protocol Implementation Conformance Statement (PICS) for each controller type and indicate which points being incorporated into the FMS are readable or writable, inputs or outputs, and analog or digital.

D. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Submit damper leakage and flow characteristics, plus size schedule for controlled dampers.

E. Shop Drawings containing the following information for each control system:

1. Schematic flow diagram showing fans, pumps, coils, dampers, valves.
2. Each control device labeled with setting or adjustable range of control.
3. Diagrams for all required electrical wiring. Clearly differentiate between factory-installed and field-installed wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
7. Listing of connected data points, including connected control unit and input device.
8. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
9. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
10. Software description and sequence of operation.

F. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring. Furnish wiring diagrams and coordination documentation for all controlled equipment furnished by other suppliers under Division 23.

G. Maintenance data for control systems equipment to include in the operation and maintenance manual. Include the following:

1. Maintenance instructions and spare parts lists for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.

4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.
6. Manufacturer's literature for flow measurement systems.

H. Field Test Reports: Procedure and certification of pneumatic control piping system.

I. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer specializing in control system installations.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing control systems similar to those indicated for this Project and that have a record of successful in-service performance.

C. Startup Personnel Qualifications: Engage specially trained personnel in direct employ of manufacturer of primary temperature control system.

D. Comply with NFPA 90A.

E. Comply with NFPA 70.

F. Coordinate equipment selection with Division 26 Section covering Fire Alarm Systems to achieve compatibility with equipment that interfaces with that system.

G. For web-based control systems, furnish additional password and access license (if required) to the Engineer for a period not less than 1-year from control system start-up.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Direct Digital Control (DDC) Systems and Components:
   a. Carrier; i-Vu® System
   b. Other manufacturers considered through Owner's prior approval only.
2. Airflow Measurement Devices:
   a. Air Monitor
   b. Paragon
   c. Tek-Air
   d. Ebtron
3. Impeller-Type Water Flow Meters:
   a. Badger
   b. Onicon
   c. Flow Research Corp.
   d. George Fischer Signet, Inc.

2.2 DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

A. Overall Conceptual Description

1. The FMS shall be designed entirely for use on intranets and internets. All networking technology shall be off the shelf, industry standard technology fully compatible with other Owner provided networks in the facility.
2. All aspects of the user interface shall be accessed via standard web browsers (Chrome, Firefox, or Microsoft Edge). Access shall be via the internet or the Owner's LAN.
3. The user interface shall be complete as described herein, providing complete tool sets, operational features, multi- panel displays, and other display features.

B. General:

1. The FMS shall consist of a number of controllers and associated equipment connected by industry standard network practices. All communication between Controllers shall be by digital means only.
2. The FMS network shall at minimum comprise of the following:
   a. Network processing, data storage and communication equipment including file servers (provided under this contract).
   b. Routers, bridges, switches, hubs, modems and like communications equipment.
   c. Active processing Controllers included in field panels.
   d. Intelligent and addressable elements and end devices.
   e. Third-party equipment interfaces.
   f. Other components required for a complete and working FMS.
3. The servers and principal network equipment shall be standard products of recognized major manufacturers available through normal PC vendor channels.
4. Provide licenses for all software residing in the FMS system and transfer these licenses to the Owner prior to completion.

C. Network:

1. The FMS Network shall utilize an open architecture capable of all of the following:
   a. Utilizing standard Ethernet communications and operate at a minimum speed of 10/100 Mb/sec.
   b. Connecting via BACnet to any controller or controlled device in accordance with ANSI/ASHRAE Standard 135.
2. The FMS network shall support both copper and optical fiber communication media.

D. Controllers:

1. General: Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC) as required to achieve performance specified. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L.
2. Building Controllers (BCs): Each shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
   a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
   b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
3. Advanced Application Controllers (AACs): Each AAC shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

a. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

4. Application Specific Controllers (ASCs): Each ASC shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
   a. Each ASC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, using the ARCNET or MS/TP Data Link/Physical layer protocol.
   b. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network.
   c. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

E. Downloading and Uploading:

1. Provide the capability to generate FMS software-based sequences, database items and associated operational definition information and user-required revisions to same at any Browser, and the means to download same to the associated controller.
2. Application software tool used for the generation of custom logic sequences shall be resident in both the application controller and the server(s) where indicated on the drawings.
3. Provide the capability to upload FMS operating software information, database items, sequences and alarms to the designated server(s).
4. The functions of this Part shall be governed by the codes, approvals and regulations applying to each individual FMS application.

2.3 WEB INTERFACE

A. General:

1. The FMS user interface shall be user friendly, readily understood and shall make maximum use of colors, graphics (including floor plan graphics), icons, embedded images, animation, text-based information and data visualization techniques to enhance and simplify the use and understanding of the FMS by authorized users.
2. User access to the FMS shall be protected by a flexible and Owner re-definable software-based password access protection. Each username shall be individually configurable with capabilities and restrictions relating to abilities (read or write) and specific building areas (wings, floors, entire building, etc.). It shall be possible to designate readability in one area of the building with writability in another area for each specific user.

B. Fault Detection and Diagnostics:

1. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the Operator.
2. Alarm Processing: System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Sequences of Operation. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.

3. Alarm Messages: Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
4. Alarm Reactions: Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
5. Alarm and Event log: Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms and archive closed alarms to the workstation or web server hard disk. Provide an audit trail by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
6. In addition to the BACnet alarm services and diagnostics, the FMS shall annunciate application alarms as required by Part 3 herein, the Sequence of Operation, and the Drawings where indicated.
7. The Owner shall have the ability to add or delete any alarm sequences and shall have the ability to route specific alarms from specific points to specific defined usernames.

C. Historical trending and data collection:

1. Trend and store point history data for all FMS points and values as selected by the user.
2. Provide sufficient server space to file all available points within the system for a period of fourteen (14) days in fifteen (15) minute intervals.
3. The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools. The data shall also be configurable within the web interface to display trends in a graphic manner utilizing colors, editable data ranges, durations, legends, and axis descriptions.
4. At a minimum, provide the capability to perform statistical functions on the historical database:
   a. Average.
   b. Arithmetic mean.
   c. Maximum/minimum values.
   d. Range difference between minimum and maximum values.
   e. Standard deviation.
   f. Sum of all values.
   g. Variance.

D. FMS Shop Drawing Graphics: Provide links within the Web Interface to corresponding controller (BC, AAC, and ASC) wiring diagrams pages from the final approved shop drawings.

2.4 CONTROL PANELS

A. Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricated panels of 0.06-inch-thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color.
2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switch; except safety devices. Mount devices with adjustments accessible through front of panel.

3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
4. Controller Diagrams: Provide a diagram inside the control panel indicating which wires landed on each controller correspond to which sensors, actuators, outputs, etc. consistent with corresponding pages within the final approved shop drawings. All hardcopy documents shall be laminated, legible, and permanently affixed inside the panel.
5. Controller Legend: Where controllers have a display screen displaying abbreviated names for sensors, actuators, setpoints, outputs, etc., provide a legend inside the control panel indicating the abbreviated and full name of each item.

2.5 SENSORS

A. Electronic Sensors: Vibration and corrosion resistant, for wall, immersion, or duct mounting as required.

1. Resistance Temperature Detectors or Thermistors:
   a. Accuracy: Plus or minus 1ºF at calibration point.
   b. Wire: Twisted, shielded-pair cable.
   c. Insertion Elements in Ducts: Use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
   d. Averaging Elements in Ducts: Use where ducts are larger than 9 sq. ft. or where prone to stratification, length as required.
   e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
   f. Room Sensors: Match room thermostats, locking cover.
   g. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
   h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
2. Humidity Sensors: Bulk polymer sensor element.
   a. Accuracy: 5 percent full range with linear output.
   b. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
3. Static-Pressure or Differential Pressure Transmitter: Non-directional sensor with suitable range for expected input, temperature compensated.
   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA or 0 - 10 VDC.
   c. Building Static-Pressure Range: 0 to 0.25 inch wg.
   d. Duct Static-Pressure Range: 0 to 5 inches wg.
4. Differential Pressure Transducer (Velocity Pressure) for airflow measured applications:
   a. Accuracy: 0.1% or better, of full scale.
   b. Operating temperature limits: 32 - 122EF.
   c. Outputs: 0-10 VDC or 4-20 mA.
   d. Auto-Zero and temperature compensation capability.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service, range suitable for system, proportional output 4 to 20 mA or 0 - 10 VDC.

B. Equipment Operation Sensors: As follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psi.
3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

C. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vapor-proof type.

D. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors, using solid-state sensors with 3-year minimum life, maximum 15-minute sensor replacement, suitable over temperature range of 23 to 130 deg F, calibrated for 50 ppm and 100 ppm, with maximum 2-minute response time to 100 ppm CO-calibration gas.

E. Carbon Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over temperature range of 23 to 130 deg F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, wall mounted.

F. Airflow Measurement Devices:

1. Provide airflow measurement devices where indicated on the plans.
2. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter or pressure transducer. Each transmitter/transducer shall have an LCD or analog display capable of displaying airflow and temperature. Airflow shall be field configurable to be displayed as a velocity or volumetric rate. Each transmitter/transducer shall operate on 24 VAC.
3. Airflow measurement devices shall have a 3% of reading accuracy over entire operating range.
4. Pressure transducers shall be specified elsewhere in this section.
5. The transmitter/transducer shall operate on 24 VAC. The transmitter/transducer shall not require an isolated power source.
6. The operating temperature range for the transmitter/transducer shall be -20ºF to 120ºF.
7. The transmitter/transducer shall be capable of communicating with the host controls using linear analog output single: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA.
8. Airflow/Temperature measuring devices shall be UL listed as an entire assembly.
9. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.
10. Manufacturer shall provide regular calibration and maintenance of the airflow measurement devices as recommended in manufacturer's literature for a period of two (2) years from installation.

G. Hydronic Flow Measuring Systems:

1. General: Flow-measuring systems include calibrated flow element, separate meter, hoses or tubing, valves, fittings, and conversion chart that is compatible with flow element, meter, and system fluid. Flow range of flow-measuring element and meter covers operating range of equipment or system where used.
2. Hydronic Impeller Flow Meters:
   a. Description: Impeller flow meter made for insertion in hydronic piping fluid flow that measures flow directly in gallons/minute. Include register to indicate total volume in gallons.

H. Airflow Switch: Paddle type with one-piece stainless-steel paddle suitable for measuring airflow and absence of airflow in ducts by responding only to the velocity of air movement. Furnish range adjusting screw to permit field adjustment to flow rate setting.

2.6 ROOM THERMOSTATS

A. Direct Digital Control (DDC) Thermostat: Thermostats shall consist of room temperature sensors with setpoint adjustment means in a wall-mounted enclosure. Furnish with the following:

1. Override button.
2. Humidity sensing (where indicated on the Drawings).
3. CO2 sensing (where indicated on the Drawings).
4. Occupancy sensing (where indicated on the Drawings).
5. Backlit Digital display of room temperature with buttons for setpoint adjustment.

2.7 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or 2-position action.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Non-spring Return Motors for Valves Larger than 2-1/2 Inches: Size for running torque of 150 inch-pounds and breakaway torque of 300 inch-pounds.
3. Spring-Return Motors for Valves Larger than 2-1/2 Inches: Size for running and breakaway torque of 150 inch-pounds.
4. Non-spring-Return Motors for Dampers Larger than 25 sq. ft.: Size for running torque of 150 inch-pounds and breakaway torque of 300 inch-pounds.
5. Spring-Return Motors for Dampers Larger than 25 sq. ft.: Size for running and breakaway torque of 150 inch-pounds.

B. Electronic Operators: Select operator for full shutoff at maximum pump differential pressure.

2.8 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class indicated. Where type or body material is not indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system.

B. Ball Valves: As follows:

1. Up to 4-inches: Brass body with stainless steel ball and stem assembly, threaded packing gland on the valve stem seal, screwed or flanged ends.
2. Hydronic Systems: As follows:
   a. Rating: Service at 100 psig for 2-way valves and 5- psig for 3-way valves.
   b. PTFE seals with EPDM o-ring backup.
   c. Sizing: 3 psi maximum pressure drop at design flow rate.
   d. Flow Characteristic: 2-way valves shall have equal percentage characteristic; 3-way valves have linear characteristics. Select operators to close valves against pump shutoff head.

C. Globe Pattern: As follows:

1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with back-seating capacity repackable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
3. Hydronic Systems: As follows:
   a. Rating: Service at 125 psi WSP and 250 deg F.
   b. Internal Construction: Replaceable plugs and seats of stainless steel or brass.

1) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

c. Sizing: 3-psi maximum pressure drop at design flow rate.

d. Flow Characteristics: 2-way valves have equal percentage characteristics; 3-way valves have linear characteristics. Select operators to close valves against pump shutoff head.

D. Terminal Unit Control Valves: Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.

1. Rating: Service at 125 psi WSP and 250 deg F.
2. Sizing: 3-psi maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: 2-way valves have equal percentage characteristics; 3-way valves have linear characteristics.
4. Operators (Modulating): Self-contained, linear motor, actuator with 60-second full travel, with transformer and single-throw, double-pole contacts.

2.9 DAMPERS

A. Dampers: AMCA-rated, parallel or opposed blade design; form frames from not less than 0.1084-inch galvanized steel with mounting holes for duct mounting; damper blades not less than 0.0635-inch galvanized steel, with maximum blade width of 8 inches.

1. Blades secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass. Ends sealed against spring-stainless-steel blade bearings. Thrust bearings at each end of every blade.
2. Operating Temperature Range: From -40 to 200 deg F.
3. For standard applications as indicated, (as selected by manufacturer's sizing techniques) with optional closed-cell neoprene edging.
4. For low-leakage applications (outdoor air) as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm/sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 inch-pounds; test in accordance with AMCA 500.

2.10 RELAYS

A. Control relays shall be UL listed plug-in type with dust cover. Contract rating, configuration and coil voltage suitable for application.

B. Time delay relays shall be UL listed solid state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

2.11 TRANSFORMERS AND POWER SUPPLIES

A. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

B. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.

C. Unit shall operate between 0 c and 50 c.

D. Unit shall be UL recognized.

2.12 SMOKE DETECTORS

A. Smoke detectors shall be located in the duct upstream of each smoke or combination fire/smoke damper. Detectors shall also be located on the wall adjacent to each smoke or combination fire/smoke damper located in plenum smoke partition.

B. In systems of over 2,000 cfm capacity smoke detectors approved for duct installation shall be installed at a suitable location in:

1. The main supply duct downstream of the unit filter and supply fan.
2. In the return air duct at each floor for systems exceeding 15,000 cfm and serving more than one floor.

C. Smoke detectors and duct housings shall be provided under Division 26. Detectors shall be compatible with existing fire alarm system and shall be approved by the Owner.

D. Detectors and duct housings used to activate smoke dampers and shut down air handlers shall be mounted under Division 23. Detectors shall be mounted in accordance with NFPA 72.

1. Sampling tubes shall extend full width of duct.
2. Provide access door at smoke detector.
3. Test/reset switches for smoke detectors are furnished and installed under Division 26.

2.13 SMOKE DAMPERS AND COMBINATION SMOKE AND FIRE DAMPERS

A. Smoke dampers and combination smoke and fire dampers will be provided under Division 23. Control of dampers shall be under this section (HVAC Controls):

1. A status panel for smoke dampers shall be provided in the ceiling below the individual dampers. Panel shall contain a red neon pilot light that shall be illuminated when damper is closed.
   a. Provide damper position interlock to ensure that smoke dampers are open 100% before air handling unit fan is started.

2.14 CONTROL CABLE

A. Electronic Cable for Control Wiring: Refer to Division 26 Sections.

B. Optical-Fiber Cable for Control Wiring: Refer to Division 26 Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field end devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment as indicated to comply with manufacturer's written instructions.

B. Install software in control units and FMS server. Implement all features of programs to specified requirements and appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve the sequence of operation specified.

D. Verify location of thermostats and other exposed control sensors with plans and room details before installation.

1. Install wall-mounted thermostats 4'-0" A.F., unless indicated otherwise. Coordinate mounting height with Architect.
2. Install wall-mounted thermostats minimum 8" away from door or window frames. Coordinate location with switches and other devices provided under other Divisions.

E. Install damper motors on outside of duct in warm areas, not where exposed to outdoor temperatures.

F. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

G. Install labels and nameplates to identify control components according to Division 23 Sections specifying mechanical identification.

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

I. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

J. Install optical-fiber cable according to Division 26 Sections.

3.3 FLOW MEASURING SYSTEM, FLOW ELEMENT AND METER INSTALLATION

A. General: Install flow meters for piping systems located in accessible locations at most readable position.

B. Locations: Install flow measuring elements and meters at discharge of each pump, at inlet of each hydronic coil in built-up central systems, and elsewhere as indicated.

C. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.

D. Install connection fittings for attachment to portable flow meters in readily accessible locations.

E. Permanently Mounted Meters for Flow Elements: Install meters on walls or brackets in accessible locations.

F. Install connections, tubing, and accessories between flow elements and meters as prescribed by manufacturer's written instructions.

G. Connect flow measuring-system elements to meters.

H. Connect flow-meter transmitters to meters.

3.4 ELECTRICAL WIRING AND CONNECTIONS

A. Install raceways, boxes, and cabinets according to Division 26.

B. Install building wire and cable according to Division 26.

C. Install signal and communication cable according to Division 26.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Except as indicated below, route all wiring in plenum rated cable secured to the structure.

3. All wiring associated with smoke detectors, smoke dampers, fire alarm shutdowns and similar systems shall be routed in conduit.
4. Bundle and harness multi-conductor instrument cable in place of single cables where a number of cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.
6. Number-code or color-code conductors, except local individual room controls, for future identification and servicing of control system.

D. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

E. Connect manual reset limit controls independent of manual control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Connect HAND-OFF-AUTO selector switches to override automatic interlock controls when switch is in HAND position.

G. Make electrical connections to power supply and electrically operated meters and devices.

H. Where not indicated otherwise, obtain power for control units from the nearest un-switched receptacle circuit.

3.5 COMMISSIONING

A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems.

B. Test and adjust controls and safeties.

C. Replace damaged or malfunctioning controls and equipment.

D. Start, test, and adjust control systems.

E. Demonstrate compliance with requirements.

F. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.6 DEMONSTRATION

A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Schedule training with Owner with at least 7 days' notice.
3. Provide operator training on data display, alarm and status descriptors, requesting data, execution of commands, and request of logs. Include a minimum of (8) hours dedicated instructor time on-site.

END OF SECTION 230900

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SECTION 230993

SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems and terminal units.

B. The Facility Management System (FMS) input/output summary is listed on the Drawings. Furnish listed points plus others required to achieve sequence of operation.

C. Where equipment is to operate using manufacturer supplied unit-mounted controls, integrate controls into the FMS utilizing a BacNet interface. Provide all necessary hardware and programming.

1.3 SAFETY AND RELIABILITY SYSTEMS

A. Smoke Detector/Air Handling Unit:

1. In systems with air handling capacity above 2,000 CFM and up to and including 15,000 CFM, the smoke detector mounted in the unit or main ductwork shall, when sensing smoke, shut down the Air Handing Unit. The smoke detectors shall be connected to the fire alarm system. The actuation of smoke detector shall activate a visible and supervisory signal at a constantly attended location. Where an outdoor condensing unit or heat pump is used it shall shut down those components.
2. In systems over 15,000 CFM, the smoke detector shall also send a signal to close motorized smoke dampers in order to isolate the Air Handling equipment (including filters) from the remainder of the system.
3. In systems over 15,000 cfm, the smoke dampers shall close (thus isolating the air handling equipment) whenever the unit fan is de-energized. The fan shall be interlocked with limit switches mounted on the smoke damper such that the fan cannot energize until all smoke dampers are fully open.
4. Integrate new air-handling equipment into the facility's existing fire alarm shutdown sequence and atrium smoke exhaust sequence.

B. Freezestat/Air Handling unit: Upon sensing temperature below the setpoint of the freezestat, air handling unit fans shall deenergize and outdoor air dampers shall close. Preheat and chilled water control valves shall fail open to the coil.

C. Smoke (or Combination) Damper/Smoke Detector: Upon sensing smoke at the detector, the damper shall close. When the damper is closed, the indicator light shall illuminate on the ceiling below the damper.

D. Upon any fan system (i.e. air handling unit, exhaust fan) shutdown, all smoke dampers (or combination smoke/fire dampers) in that fan system's duct system shall close. Coordinate damper closure sequence/fan system shutdown with fire alarm system contractor. Fan restart shall require damper end switch proof of opening in order to reenergize fan(s). (Engineer note – certain specialty areas may require dampers to stay open as part of a smoke control sequence, or to close without shutting down the ahu system.)

E. High Limit Static/Low Limit Static/Air Handling Unit: Provide high limit static pressure switch at unit discharge or in duct system prior to first duct mounted device to shut down air handling unit's fan(s) should duct static exceed setpoint. On systems with return fans, provide low limit static pressure switch at unit return connection or after the last duct mounted device to shut down air handling unit's fan(s) should duct static fall below setpoint.

F. Auto Restart: All HVAC systems and equipment shall be configured such that normal operation is resumed after a power failure.

G. Dead Band: Where used to control both heating and cooling, zone thermostats shall be capable of providing a temperature dead band of at least 5ºF in accordance with ASHRAE standard 90.1.

H. Setback/Overrides:

1. All HVAC systems/units shall be scheduled for operation by the DDC system. The occupancy schedule shall be prescribed by the Owner.
2. In unoccupied mode, the temperature setpoint shall be set back to 50ºF for heating and 85ºF for cooling. Unit supply fans shall run only as required to maintain setback temperatures. The outdoor air dampers shall be closed, and exhaust fans shall not operate.
3. Prior to the occupancy period, the HVAC systems shall energize to cool or warm the spaces to normal occupied setpoint. Outdoor air dampers shall remain closed, and exhaust fans shall remain off during warmup/cool-down.
4. Outdoor air dampers shall open to setpoint, and general exhaust fans shall energize only when setpoint is reached and the building is in occupied mode.
5. Individual HVAC systems shall be equipped with override buttons on the unit thermostats. When the button is activated, the unit shall operate in occupied mode for a period determined by the Owner.

I. Boiler Rooms: For each boiler room, furnish an emergency stop palm button located adjacent to each room exit. Upon activation, all gas-fired appliances and associated equipment shall de-energize and all fuel valves shall close. The button(s) shall be furnished with a clear hinged cover to prevent accidental activation. Coordinate with plumbing contractor for locations and requirements of plumbing-related gas-fired equipment.

1.4 CENTRAL PLANT SYSTEMS

A. Heating Water System:

1. The secondary heating water pumps shall run in lead/standby mode, with the lead pump alternated to equalize run time.
2. When scheduled to run by the FMS, the lead secondary pump shall energize. Modulate in response to the remote loop differential pressure sensor.
3. When the lead secondary pump is called to run, but no flow is recognized at the flow meter, the lead pump shall deenergize, the standby pump shall energize and an alarm shall be generated.
4. When flow is detected in the secondary loop and the heating water supply temperature in the secondary loop is below setpoint, the primary pump serving the lead boiler shall energize. Upon proof of flow in the primary branch, the boiler shall fire and run based on unit mounted controls to maintain supply temperature setpoint.
5. The second boiler/pump shall run in the same manner indicated for the lead boiler/pump, whenever the lead boiler cannot maintain the secondary loop of temperature setpoint. The boilers shall be alternated to equalize run time.
6. Secondary supply temperature and boiler controller setpoints shall be reset based on outdoor temperature.

B. Chilled Water System:

1. The chilled water pumps shall be activated and deactivated by the FMS panel when the outdoor air temperature reaches 60ºF (adjustable.) Secondary pumps shall operate in lead/lag mode and be alternated to equalize run time.
2. DDC controls shall modulate variable frequency drive of the chilled water pumps to maintain a constant pressure differential, measured by a sensor located as shown on building drawings. (Sensor shall be in remote portion of the chilled water system.)
3. The chiller shall be activated whenever there is a call for cooling as described above. When enabled, the chiller's internal controls shall start the associated primary chilled water and condenser water pumps. After all internal safeties are satisfied, the compressor start sequences shall be initiated.
4. When active, chiller shall operate under internal controls to maintain 45ºF (adjustable) leaving water temperature.
5. All chiller controls shall be approved by the chiller manufacturers, in writing, by notation on the control shop drawing.

1.5 AIR HANDLING SYSTEMS

A. VAV Air Handling Unit:

1. When scheduled to run by the Facility Management System (FMS) the outdoor air damper shall open to the minimum position (outside air damper shall be closed during unoccupied periods). The supply fan shall energize and run, with the fan speed modulated via the VFD in response to the static pressure sensor mounted 2/3 down the main supply duct.
2. The pre-heat or chilled water control valves shall modulate in response to the supply air temperature sensor. Heating and cooling shall not be active simultaneously.
3. Outdoor air and return air dampers shall be modulated to maintain a constant airflow offset between supply airflow and return airflow.
4. Economizer: When the outdoor air enthalpy falls below the return air enthalpy, the outdoor air, return air and relief dampers shall modulate to maximum free cooling. Supply air temperature shall not fall below 50ºF in economizer mode.
5. When economizer mode is initiated, the return air damper closes and the relief and outdoor air dampers open completely. When the unit is in economizer mode and the discharge air temperature falls below set point, the return air damper shall begin modulating open and the outdoor air damper shall begin modulating toward minimum position in order to maintain minimum discharge air temperature. When the return air damper is fully open and the outdoor air damper is at its minimum position (in economizer mode), and the discharge air temperature is still below setpoint, the preheat control valve shall modulate open.

1.6 TERMINAL UNITS

A. VAV Terminal Unit:

1. On rise in space temperature, the primary air valve shall modulate to the maximum position.
2. On drop in space temperature, the primary air valve shall modulate to the minimum position. On further drop in space temperature, the reheat control valve shall open.

B. Fan Coil Units (4-pipe Models):

1. When enabled by the FMS, the fan shall run continuously.
2. When call for cooling, chilled water control valve shall modulate to maintain thermostat setpoint.
3. When called for heating, heating water control valve shall modulate to maintain setpoint.

1.7 UNITARY SYSTEMS

A. Split Systems (ductless):

1. Split systems shall be controlled by individual thermostats furnished by the manufacturer. Heating or cooling shall be energized as required to maintain space temperature.
2. The systems serving the IT Rooms shall be integrated into the FMS through the unit's BacNet interface.

1.8 HEATING, VENTILATION AND HUMIDIFICATION SYSTEMS

A. Heat Trace: The heat trace (piping) shall be self-regulating. An outdoor thermostat shall lock the heat trace out when the temperature exceeds 40ºF.

B. Fans: See fan schedule.

1. Exhaust fans controlled by the FMS shall run continuously when the building is occupied. When unoccupied, these fans shall turn off.

1.9 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Shop Drawings showing operating sequences of various equipment, devices, components, and materials included in the Text and defining the components' contribution to the system.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993

SECTION 232113

HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes piping systems for hot water heating, chilled water cooling and condensate drain piping. Piping materials and equipment specified in this Section include the following:

1. Pipes, fittings, and specialties.
2. Special-duty valves.
3. Hydronic specialties.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, accessories, and installation instructions for each hydronic specialty and special-duty valve specified.

1. Submit flow and pressure drop curves for diverting fittings and calibrated plug valves, based on manufacturer's testing.
2. Grooved joint products shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series number.

C. Shop Drawings detailing pipe anchors, special pipe support assemblies, alignment guides, and expansion joints and loops.

D. Field test reports indicating and interpreting test results for compliance with performance requirements specified in Part 3 of this Section.

E. Maintenance data for hydronic specialties and special-duty valves to include in the operation and maintenance manual.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with the following provisions:

1. ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
2. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
3. Welding Standards: Qualify welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.5 COORDINATION

A. Coordinate layout and installation of piping with equipment and with other installations.

B. Coordinate pipe sleeve installation for foundation wall penetrations.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

E. Coordinate size and location of concrete housekeeping pads. Cast anchor-bolt inserts into pad.

F. Coordinate installation of pipe sleeves for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping for fire and smoke wall and floor assemblies.

1.6 EXTRA MATERIALS

A. Maintenance Stock: Furnish a sufficient quantity of chemicals for initial system startup and for preventive maintenance for one year from Material Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Calibrated Plug Valves (Balancing Valves):
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Flow Design, Inc.
   d. Griswald
   e. Gerand Engineering Co.
   f. Hydronic Components, Inc. (HCI)
   g. ITT Fluid Technology Corp.; ITT Bell & Gossett.
   h. Mepco
   i. Taco, Inc.
   j. Tour and Anderson
   k. Victaulic
2. Pressure-Reducing Valves:
   a. Amtrol, Inc.
   b. Anvil International
   c. Armstrong Pumps, Inc.
   d. ITT Hoffman; ITT Fluid Handling Div.
3. Safety Relief Valves:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT Fluid Technology Corp.; ITT McDonnell & Miller.
   e. Watts
4. Compression Expansion Tanks:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Fluid Technology Corp.; ITT Bell & Gossett.
   d. Taco, Inc.
5. Air Separators:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Fluid Technology Corp.; ITT Bell & Gossett.
   d. Taco, Inc.

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3 "Pipe Applications" Article for identifying where the following materials are used.

B. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

C. Steel Pipe, 2-Inch NPS and Smaller: ASTM A 53, Type S (seamless), Grade B, Schedule 40, plain ends.

D. Steel Pipe, 2-1/2- to 12-Inch NPS: ASTM A 53, Type E (electric-resistance welded), Grade A, Schedule 40, plain ends.

E. Pre-insulated Underground Jacketed Piping Systems:

1. All underground lines as shown on the contract drawings shall be Thermacor Process “Ferro-therm” or equivalent.
2. All straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions and designed to minimize the number of field welds. The design shall be computer analyzed by the piping system manufacturer to determine stresses and movements of the service pipe and to insure that the system design is in strict conformance with ANSI B31.1 latest edition, and stamped by a registered professional engineer. Factory-trained field technical assistance shall be provided for the critical periods of the installation., i.e. unloading, field joint instruction, cold springing and testing.
3. Internal piping shall be carbon steel for all pipe sizes 2" and larger A53, Grade B, ERW standard weight. Pipe sizes 1-1/2' and smaller shall be A106/A53 seamless. All joints shall be butt welded for sizes 2" and larger, and socket welded for 1-1/2" and smaller.
4. Gland seals, end seals and anchors shall be designed and factory prefabricated to prevent the moisture ingress into the system. Subassemblies shall be designed to allow for complete draining, drying and testing of the conduit system.
5. Insulation shall be polyurethane foam. Insulation thickness shall be minimum 1".
6. The outer jacket shall be extruded high density polyethylene (HDPE) conforming to ASTM 3350 with thickness of 125 mils minimum.
7. Service pipe insulation shall be spray applied nominal 2 pound per cubic foot density, polyurethane foam for straight sections and preformed polyurethane foam for all fittings. The insulation shall be applied to the minimum thickness specified below. The insulation thickness shall not be less than indicated in these specifications.

Pipe Size (inc.)	Insulation Thickness (in.)
1	1
1½ - 3	1.5
4 - 6	1.5
8 - 14	1.5
16 - 20	1.5
22 - 30	1.5

2.3 FITTINGS

A. Wrought-Copper Fittings: ASME B16.22.

B. Wrought-Copper Unions: ASME B16.22.

C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300.

D. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

F. Cast-Iron Threaded Flanges: ASME B16.1, Classes 125 and 250; raised ground face, bolt holes spot faced.

G. Wrought-Steel Fittings: ASTM A 234, Standard Weight.

H. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.

2. End Connections: Butt welding.
3. Facings: Raised face.

I. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure, 250 deg F maximum operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

2.4 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

B. Brazing Filler Metals: AWS A5.8, Classification BAg 1 (silver).

C. Welding Materials: Comply with Section II, Part C of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

D. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 VALVES

A. Valves are specified in Division 23 Section "Valves."

B. Refer to Part 3 "Valve Applications" Article for specific uses and applications for each valve specified.

C. Calibrated Plug Valves (Balancing Valves): 125-psig working pressure, 250 deg F maximum operating temperature, bronze body, plug valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral Schrader valves. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valves 2-inch NPS and smaller shall have threaded connections and 2-1/2-inch NPS valves shall have flanged connections.

D. Pressure-Reducing Valves: Diaphragm-operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

E. Safety Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heat capacity; according to ASME Boiler and Pressure Vessel Code, Section IV.

2.6 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with 1/8-inch NPS discharge connection and 1/2-inch NPS inlet connection. Pipe outlet to floor drain.

B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure, 240 deg F operating temperature; with 1/4-inch NPS discharge connection and 1/2-inch NPS inlet connection.

C. Bladder-Type Expansion Tanks: Welded carbon steel for 125-psig working pressure, 240 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by a heavy-duty bladder sealed into tank. Provide taps for pressure gage and air-charging fitting and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Fabricate and test tank with taps and supports, and label according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

D. Air Separators: Air separators to be coalescing style combination air and sediment separator utilizing a coalescing medium and magnetic insert to remove impurities from the piping system. Separator body constructed of carbon steel. Coalescing medium to be Type 326

stainless steel and have 58% open area, removable end cover for coalescing medium access, connections for air vent, blow down valve and skim valve and magnetic insert with minimum 13,550 gauss strength neodymium 45H magnet. Separator to be designed, constructed, inspected and stamped per ASME Section VIII, Division 1.

E. Chemical Feeder: Bypass-type chemical feeders of 2-gal. capacity, welded steel construction; 125-psig working pressure; complete with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated to prevent accumulation of scale and corrosion in piping system and connected equipment and based on a water analysis of makeup water.

F. Diverting Fittings: 125-psig working pressure, 250 deg F maximum operating temperature; cast-iron body with threaded ends or wrought copper with soldered ends. Indicate flow direction on fitting.

G. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B) or cast bronze body (ASTM B-584), flanged ends for 2-1/2-inch NPS and larger, threaded connections for 2-inch NPS and smaller, bolted cover, perforated Type 304 stainless-steel basket, and bottom drain connection.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

A. Hot and Chilled Water, 2-Inch NPS and Smaller: Type L drawn-temper copper tubing with brazed joints or steel pipe with threaded joints.

B. Hot and Chilled Water, 2-1/2-Inch NPS and Larger: Steel pipe with welded and flanged joints or grooved joints.

C. Makeup Water Lines: Type "L" drawn-temper copper tubing with soldered joints.

D. Chilled Water Belowground: Pre-insulated underground piping system.

3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Use gate, ball, and butterfly valves.
2. Throttling Duty: Use globe, ball, and butterfly valves.

B. Install shut-off-duty valves at each branch connection to supply and return mains, at supply connections to each piece of equipment, and elsewhere as indicated.

C. Install calibrated plug valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.

D. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage. Install manual air vents at high points as required to relieve air from the system.

E. Install triple duty valves on each pump discharge and elsewhere as required to control flow direction.

F. Install safety relief valves on hot water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

G. Install pressure-reducing valves on hot water generators and elsewhere as required to regulate system pressure.

3.3 PIPING INSTALLATIONS

A. Install piping according to Division 23 Sections.

B. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

C. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4inch NPS ball valve, and short 3/4-inch NPS threaded nipple and cap.

D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

F. Install branch connections to mains using tee fittings in main with takeoff out bottom of main, except for up-feed risers with takeoff out top of main line.

G. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated. Unions are not required at flanged connections.

H. Install flanges on valves, apparatus, and equipment having 2-1/2-inch NPS and larger connections.

I. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points if required.)

J. Install flexible connectors at inlet and discharge connections to pumps, air handling units and other vibration-producing equipment.

K. Install strainers on supply side of each control valve, pressure-reducing valve, pressure-regulating valve, solenoid valve, in-line pump, and elsewhere as indicated. Install 3/4-inch NPS nipple and ball valve in blow-down connection of strainers 2-inch NPS and larger.

L. Anchor piping to ensure proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

A. General: Hanger, support, and anchor devices are specified in Division 23 Sections. Conform to requirements below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet.
2. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal runs 20 feet or longer, supported on a trapeze.
3. Spring hangers to support vertical runs.

C. Install hangers for steel piping with the following minimum rod sizes and maximum spacing:

1. 3/4-Inch NPS: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-Inch NPS: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. 1-1/2-Inch NPS: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2-Inch NPS: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2-Inch NPS: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3-Inch NPS: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4-Inch NPS: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6-Inch NPS: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8-Inch NPS: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. 10-Inch NPS: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. 12-Inch NPS: Maximum span, 23 feet; minimum rod size, 7/8 inch.

D. Install hangers for drawn-temper copper piping with the following minimum rod sizes and maximum spacing:

1. 3/4-Inch NPS: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1-Inch NPS: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. 1-1/2-Inch NPS: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2-Inch NPS: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2-Inch NPS: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3-Inch NPS: Maximum span, 12 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at each floor.

3.5 PIPE JOINT CONSTRUCTION

A. Refr to Division 23 Sections for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, grooved and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in system, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents where indicated.

C. Install in-line air separators in pump suction lines. Run piping to expansion tank with a 2 percent upward slope toward tank. Install drain valve on units 2-inch NPS and larger.

D. Install shot-type chemical feeders in each hydronic system where indicated; in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Unless noted otherwise on plans, piping size for supply and return shall be same size as equipment connections. Furnish piping header where coil has multiple connections.

B. Install control valves in accessible locations close to equipment.

C. Install bypass piping with globe valve around control valve where indicated. Where multiple, parallel control valves are installed, only one bypass is required.

D. Install pressure gages at coil connections.

3.8 FIELD QUALITY CONTROL

A. Testing Preparation: Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, un-insulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment that is not subjected to test pressure from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Flanged joints where blinds are inserted to isolate equipment need not be tested.
5. Install relief valve set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Testing: Test hydronic piping as follows:

1. Use ambient temperature water as testing medium, except where there is risk of damage due to freezing. Another liquid may be used if it is safe for workers and compatible with piping system components.
2. Use vents installed at the high points of system to release trapped air while filling system. Use drains installed at low points for complete removal of liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Check to verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

3.9 ADJUSTING AND CLEANING

A. After completing system installation, including outlet fittings and devices, inspect finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Flush hydronic piping systems with clean water. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

C. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

D. Chemical Treatment: Provide a water analysis prepared by chemical treatment supplier to determine type and level of chemicals required to prevent scale and corrosion. Perform initial treatment after completing system testing.

3.10 COMMISSIONING

A. Fill system and perform initial chemical treatment.

B. Check expansion tanks to determine that they are not air bound and that system is completely full of water.

C. Perform these steps before operating the system:

1. Open valves to fully open position. Close coil bypass valves.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Check and set operating temperatures of boilers and chillers to design requirements.
8. Lubricate motors and bearings.

END OF SECTION 232113

SECTION 232123

HVAC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following categories of HVAC pumps for hydronic systems:

1. End-suction pumps.

1.3 PERFORMANCE REQUIREMENTS

A. Pump Pressure Ratings: At least equal to system's maximum operating pressure at point where installed, but not less than specified.

B. Selection Point: All pump design operating points shall be at less than 80% of the end-of-curve flow rate. Pump inlet fluid velocity shall not exceed 12 feet per second.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product data including certified performance curves and rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate pump's operating point on curves.

C. Shop drawings showing pump layout and connections. Include setting drawings with templates, directions for installation of foundation and anchor bolts, and other anchorages.

D. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating between manufacturer-installed wiring and field-installed wiring.

E. Product certificates signed by manufacturers of pumps, certifying accuracies under specified operating conditions and compliance with specified requirements.

F. Maintenance data for pumps to include in the operation and maintenance manual. Include startup instructions.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following:

1. ASME B31.9 "Building Services Piping" for piping materials and installation.
2. Hydraulic Institute's "Standards for Centrifugal, Rotary & Reciprocating Pumps" for pump design, manufacture, testing, and installation.
3. UL 778 "Standard for Motor Operated Water Pumps" for construction requirements. Include UL listing and labeling.
4. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labeling.
5. NFPA 70 "National Electrical Code" for electrical components and installation.

B. Single-Source Responsibility: Obtain each category of pumps from 1 source and by a single manufacturer. Include responsibility and accountability to answer questions and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered for prior approval.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pumps in dry location.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

D. Extended Storage Longer than 5 Days: Dry internal parts with hot air or vacuum-producing device. Coat internal parts with light oil, kerosene, or antifreeze after drying. Dismantle bearings and couplings; dry; coat with acid-free, heavy oil; tag; and store in dry location.

E. Comply with pump manufacturer's rigging instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Duty Pumps and Specialty Fittings:
   a. Armstrong Pumps, Inc.
   b. Buffalo Pumps, Inc.
   c. Fairbanks Morse Pump Corp.
   d. Federal Pump Corp.
   e. Flo Fab
   f. General Signal: Aurora Pump
   g. Goulds Pumps, Inc.
   h. Bell & Gossett
   i. Paco Pumps, Inc.
   j. Patterson
   k. Peerless Pump Co.
   l. Swaby Manufacturing Co.
   m. Taco, Inc.
   n. Weil Pump Co.
2. Pump Specialty Fittings:
   a. Anvil International
   b. Central Sprink, Inc.
   c. Ductilic, Inc.
   d. Grinnell Corp.
   e. National Fittings, Inc.
   f. Star Pipe Products, Inc.; Star Fittings Div.

2.2 PUMPS, GENERAL

A. General: Factory assembled and tested.

B. Base-Mounted Pumps: Include pump casings that allow removal and replacement of impellers without disconnecting piping.

C. Motors: See Division 23 “Motors”. Note special requirements for motors driven by variable frequency drives.

D. Types, Sizes, Capacities, and Characteristics: As indicated.

E. Factory Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.

F. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3 SEPARATELY COUPLED, END-SUCTION PUMPS

A. Description: Base-mounted, centrifugal, separately coupled, end-suction, single-stage, bronze-fitted, radially split case design; rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F. Include back-pull-out design, except where other design is indicated, and the following:

1. Casing: Cast iron, with flanged piping connections, drain plug in bottom of volute, and threaded gage tappings at inlet and outlet flange connections.

B. Description: Supported-volute, centrifugal, separately coupled, end-suction, single-stage, bronze-fitted, radially split case design; rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F. Include back-pull-out design, except where other design is indicated, and the following:

1. Casing: Cast iron, with flanged piping connections, drain plug in bottom of volute, and threaded gage tappings at inlet and outlet flange connections. Include integral feet or other means on volute to support weight of casing and attached piping.
2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, keyed to shaft, and secured by locking cap screw.
3. Wearing Rings: Replaceable, bronze casing ring.
4. Shaft and Sleeve: Steel shaft with bronze sleeve.
5. Seals: Mechanical type. Include carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
6. Coupling: Flexible-spacer type, capable of absorbing torsional vibration and shaft misalignment. Include flange and sleeve section that can be disassembled and removed without removing pump or motor.
7. Coupling Guard: Steel, removable, and attached to mounting frame. Comply with OSHA requirements.
8. Mounting Frame: Welded-steel frame and cross members, factory-fabricated from ASTM A 36 channels and angles. Fabricate for mounting pump casing, coupling guard, and motor. Grind welds smooth before application of factory finish. Field-drill motor-mounting holes for field-installed motors.
   a. Option: Frame may be cast iron instead of steel.
9. Motor: Secured to mounting frame, with adjustable alignment.

2.4 PUMP SPECIALTY FITTINGS

A. Include the following pump specialty fittings with end connections matching pump and piping:

1. Suction Diffuser: Angle or straight pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting. Include bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.

2. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting. Include drain plug and bronze-fitted shutoff, balancing, and check valve features. Include Schrader fittings for differential pressure (flow) measurement.

2.5 GENERAL-DUTY VALVES

A. Refer to Division 23 Section "Valves" for general-duty valves.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting performance of pumps.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 CONCRETE

A. Install concrete bases of dimensions indicated for pumps. Refer to Division 23 sections.

3.3 INSTALLATION

A. Install pumps according to manufacturer's written installation and alignment instructions.

B. Install pumps in locations indicated and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so that piping is not supported by pumps.

D. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump base plate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting them on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust alignment of pump and motor shafts for angular and parallel alignment by 1 of 2 methods specified in the H.I.'s Standards for Centrifugal, Rotary & Reciprocating Pumps, "Instructions for Installation, Operation and Maintenance" (laser or dial gauge.)

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Fill base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

E. Alignment Tolerances: According to manufacturer's recommendations.

3.5 CONNECTIONS

A. General: Install shutoff valve and strainer on pump suction and check valve and shutoff valve in pump discharge, except where other arrangement is indicated.

B. Connect piping to pumps as indicated. Install valves that are the same size as piping.

C. Install suction and discharge pipe sizes equal to or greater than the diameter of pump nozzles.

D. Install suction diffuser and shutoff valve on suction side of base-mounted pumps.

E. Install triple-duty valve on discharge side of base-mounted pumps.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps and where indicated. Install between pump casing and valves, except where other arrangement is indicated.

G. Install thermometers where indicated.

H. Install pressure gages on pump where indicated. Install at integral pressure gage tappings where provided.

I. Install electrical connections for power, controls, and devices.

J. Electrical power and control wiring and connections are specified in Division 26 Sections.

3.6 FIELD QUALITY CONTROL

A. Check suction piping connections for tightness to avoid drawing air into pumps.

B. Clean strainers.

C. Set pump controls.

3.7 COMMISSIONING

A. Final Checks Before Startup: Perform the following preventive maintenance operations and checks before startup:

1. Lubricate bearings.
2. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
3. Check that pumps are free to rotate by hand. Pumps for handling hot liquids shall be free to rotate with pump hot and cold. Do not operate pump if it is bound or even drags slightly until cause of trouble is determined and corrected.
4. Check that pump controls are correct for required application.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power:

1. Prime pumps, opening suction valve, closing drains, and preparing pumps for operation.
2. Open circulating line valves if pumps should not be operated against dead shutoff.
3. Start motors.

4. Open discharge valves slowly.
5. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
6. Check general mechanical operation of pumps and motors.
7. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

C. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except that discharge valves are opened sometime before motors are started.

D. Refer to Division 23 sections for detailed requirements for testing, adjusting, and balancing hydronic systems.

END OF SECTION 232123

SECTION 232300

REFRIGERANT PIPING AND CONDENSATE DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications, including pipes, tubing, fittings, and specialties; special-duty valves; and refrigerants. It also includes piping used for air conditioning condensate drainage.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each valve type and refrigerant piping specialty specified.

C. Shop Drawings showing layout of refrigerant piping, specialties, and fittings, including pipe and tube sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.

1. Refrigerant piping indicated is schematic only. Size and design the layout and installation of the piping, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and conformance with warranties of connected equipment.

D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.

E. Maintenance data for refrigerant valves and piping specialties to include in the operation and maintenance manual.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Qualify brazing and welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

B. Regulatory Requirements: Comply with provisions of the following codes:

1. ASME B31.5, "Refrigeration Piping."
2. ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Refrigerants:
   a. Allied Signal Inc.; Genetron Refrigerants.
   b. DuPont Company; Fluorochemicals Div.
   c. Elf Atochem North America, Inc.
   d. ICI Americas Inc.; Fluorochemicals Bus.
2. Refrigerant Valves and Specialties:
   a. Danfoss Electronics, Inc.
   b. Eaton Corporation; Industrial Control Div.
   c. Emerson Electric Company; Alco Controls Div.
   d. Henry Valve Company.
   e. Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
   f. Sporlan Valve Company.

2.2 PIPES AND TUBES

A. Copper Tube: ASTM B 280, Type ACR.

B. Copper Tube: ASTM B 88, Type L.

C. Polyvinyl Chloride (PVC) Plastic Pipe: ASTM D1785 Schedule 40.

2.3 PIPE AND TUBE FITTINGS

A. Copper Fittings: ASME B16.22, wrought-copper streamlined pattern.

2.4 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

2.5 VALVES

A. Solenoid Valves: Conform to ARI 760; 250 deg F temperature rating, 400-psig working pressure; forged brass, with PTFE valve seat, 2-way straight-through pattern, and solder-end connections; manual operator; with NEMA 250, Type 1 solenoid enclosure with 1/2-inch conduit adapter, and 24-V normally closed holding coil.

B. Pressure-Regulating Valves: Conform to ARI 770; direct acting, brass with pilot operator, stainless-steel diaphragm, standard coil, and solder-end connections.

C. Pressure Relief Valves: Straight or angle brass body and disc, neoprene seat, factory sealed and ASME labeled, for standard pressure setting.

D. Thermal Expansion Valves: Conform to ARI 750; thermostatic-adjustable, modulating type; size as required and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.

E. Hot-Gas Bypass Valve: Adjustable, sized for capacity equal to last step of compressor unloading; solder-end connections.

2.6 REFRIGERANT PIPING SPECIALTIES

A. Moisture/Liquid Indicators: 500-psig operating pressure, 200 deg F operating temperature; forged-brass body, with replaceable, polished, optical viewing window with color-coded moisture indicator, and solder-end connections.

B. Permanent Filter-Dryer: 500-psig maximum operating pressure, 225 deg F maximum operating temperature; steel shell, and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

2.7 RECEIVERS

A. 6-Inch Diameter and Smaller: ARI 495, UL listed, steel, brazed; 400-psig pressure rating, with tappings for inlet, outlet, and pressure relief valve.

2.8 REFRIGERANT

A. ASHRAE 34, R-410-A: Pentofluoroethane Difluouromethane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for compliance with requirements for installation tolerances and other conditions affecting performance of refrigerant piping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Aboveground refrigerant piping: Type ACR copper tubing.

B. Aboveground condensate drain piping: Type L copper tubing.

3.3 INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

B. Basic piping installation requirements are specified in Division 23.

C. Install piping in short and direct arrangement, with minimum number of joints, elbows, and fittings.

D. Arrange piping to allow normal inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.

E. Install piping with adequate clearance between pipe and adjacent walls and hangers, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

F. Insulate all refrigerant lines on inverter-driven split systems.

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

G. Install branch lines to parallel compressors of equal length, and pipe identically and symmetrically.

H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope of 0.4 percent downward away from compressor.
2. Install horizontal suction lines with a uniform slope of 0.4 percent downward to compressor.
3. Install traps and double risers where indicated or where required to entrain oil in vertical runs.
4. Liquid lines may be installed level.

J. Use fittings for changes in direction and branch connections.

K. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

L. Reduce pipe sizes using eccentric reducer fittings installed with level side down.

M. Install refrigerant valves according to manufacturer's written instructions.

N. When brazing, remove solenoid-valve coils; remove sight glasses; and remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties. Do not apply heat near bulb of expansion valve.

O. Electrical wiring for solenoid valves is provided under Division 23 and specified in Division 26 Sections. Coordinate electrical requirements and connections.

P. Mount thermostatic expansion valves in any position, close to evaporator.

1. Where refrigerant distributors are used, mount directly on expansion-valve outlet.
2. Install valve so diaphragm case is warmer than bulb.
3. Secure bulb to clean, straight, horizontal section of suction line using 2 bulb straps. Do not mount bulb in a trap or at the bottom of the line.
4. Where external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

Q. Install pressure relief valves as required by ASHRAE 15. Pipe pressure relief valves on receivers to outdoors.

R. Charge and purge systems, after testing, and dispose of refrigerant following ASHRAE 15 procedures.

S. Charge system per industry accepted standards for systems utilizing R-410A, or manufacturer’s recommended procedures if more stringent than industry standards. The following is an outline of the triple evacuation method.

1. Pull initial vacuum on the line set testing for a leak. If it holds then pressure test with Nitrogen at 300 psi minimum.
2. Pump system down, recharge with Nitrogen to 2 psi. Perform this step two times.
3. Pump system down, re-pressurize with Nitrogen and then evacuate system to 500 microns. Hold for 30 minutes.
4. Break vacuum with refrigerant and charge per manufacturer’s directions.

3.4 HANGERS AND SUPPORTS

A. General: Hangers, supports, and anchors are specified in Division 23 Sections. Provide according to ASME B31.5 and MSS SP-69.

B. Adjustable steel clevis hangers or swivel loop hangers for individual horizontal runs less than 20 feet in length.

C. Roller hangers and spring hangers for individual horizontal runs 100 feet or longer.

D. Pipe rollers for multiple horizontal runs, 100 feet or longer supported by a trapeze.

E. Spring hangers to support vertical runs.

F. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes. Tube sizes are nominal or standard tube sizes as expressed in ASTM B 88.

1. 1/2 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. 5/8 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. 1 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
4. 1-1/4 Inches: Maximum span, 72 inches; minimum rod size, 1/4 inch.
5. 1-1/2 Inches: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. 2 Inches: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. 2-1/2 Inches: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. 3 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. 4 Inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.

G. Support vertical runs at each floor.

3.5 PIPE JOINT CONSTRUCTION

A. Basic pipe and tube joint construction is specified in Division 23 Sections.

B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent formation of scale.

3.6 VALVE INSTALLATIONS

A. Install refrigerant valves according to manufacturer's written instructions.

B. Provide liquid line solenoid valves for 7½-ton systems and larger, and where recommended by the HVAC equipment manufacturer.

1. Install solenoid valves in horizontal lines with coil at top.
2. Electrical wiring for solenoid valves is provided under Division 22 and specified in Division 26 Sections. Coordinate electrical requirements and connections.

C. Provide thermal expansion valve (TXV) or electronic expansion valve (EEV) on all systems:

1. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.
2. Size valves to provide full rated capacity of cooling coil serviced. Coordinate selection with evaporator coil and condensing unit.
3. Install valves in accordance with equipment and valve manufacturer’s instructions.

D. Install pressure-regulating and relief valves as required by ASHRAE 15.

3.7 SPECIALTIES APPLICATION AND INSTALLATION

A. Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.

B. Install pressure relief valves on ASME receivers, and pipe to outdoors.

C. Install filter-dryers in liquid line adjacent to receivers, coils and before each solenoid valve.

D. Install receivers on systems 5 tons and larger, and on systems with long piping runs, sized to accommodate pump-down charge.

3.8 CONNECTIONS

A. Electrical: Conform to applicable requirements of Division 26 Sections for electrical connections.

3.9 FIELD QUALITY CONTROL

A. Inspect and test refrigerant piping according to ASME B31.5, Chapter VI.

1. Pressure test with nitrogen per accepted industry practices using soap bubbles or electronic leak detector. Test to no leakage.

B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

C. Repair leaks using new materials; retest.

3.10 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements. Adjust hot gas bypass valve for proper unloading.

3.11 CLEANING

A. Before installation of copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

3.12 COMMISSIONING

A. Charge system per industry accepted standards for systems utilizing R-410A, or manufacturer's recommended procedures if more stringent than industry standards. The following is an outline of the triple evacuation method.

1. Pull initial vacuum on the line set testing for a leak. If it holds then pressure test with Nitrogen at 300 psi minimum.
2. Pump system down, recharge with Nitrogen to 2 psi. Perform this step two times.
3. Pump system down, re-pressurize with Nitrogen and then evacuate system to 500 microns. Hold for 30 minutes.
4. Break vacuum with refrigerant and charge per manufacturer's directions.

END OF SECTION 232300

SECTION 232500

CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes water-treatment systems for the following:

1. Hot-water heating systems.
2. Chilled-water systems.

1.3 SYSTEM DESCRIPTION

A. Closed System: One bypass feeder on each system, with isolating and drain valves installed around balancing valve downstream of circulating pumps, unless otherwise indicated.

1. Introduce closed system treatment through bypass feeder when required or indicated by test.
2. Performance: Water treatment sized and equipped to treat raw water available at Project site to sustain the following water characteristics:
   a. Hardness: 0.00.
   b. Iron: 0.00.
   c. Total Dissolved Solids (TDS): 1500 to 1750 ppm (as CaCO3).
   d. Silica: 60 ppm or less.
   e. pH: 10.5 or above.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product data for each type of product specified. Include manufacturer's technical product data, rated capacities of selected equipment clearly indicated, water-pressure drops, weights (shipping, installed, and operating), furnished specialties, accessories, and installation and startup instructions.

C. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

D. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.

E. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

F. Maintenance data for chemical water treatment to include in the operation and maintenance manual. Include detailed manufacturer's instructions and parts list for each item of equipment, control, and accessory. Include troubleshooting maintenance guide.

1.5 QUALITY ASSURANCE

A. Supplier Qualifications: A recognized chemical water treatment supplier with warehousing facilities in the Project's vicinity and that is or employs an experienced consultant, available at reasonable times during the course of the Work to consult with Contractor, Design Professional, and Owner about water treatment.

B. Chemical Standards: Meet state and local pollution-control regulations.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.6 MAINTENANCE

A. Service Period: Provide chemicals and service program for period of one year from startup date of equipment, including the following:

1. Initial water analysis and recommendations.
2. Startup assistance.
3. Training of operating personnel.
4. Periodic field service and consultation.
5. Customer report charts and log sheets.
6. Laboratory technical assistance.
7. System cleanout.

1.7 EXTRA MATERIALS

A. Furnish the following extra materials, matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.

B. Chemicals: Furnish quantity equal to one year of operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chemical Water Treatment Products:
   a. Anderson Chemical Co., Inc.
   b. Betz Inc.
   c. Grace: W.R. Grace & Co.; Dearborn Div.
   d. Metro Group, Inc.; Metropolitan Refining Div.
   e. Nalco Chemical Co.
   f. Chemtreat, Inc.

2.2 CHEMICAL WATER TREATMENT SYSTEM

A. Bypass (Pot) Feeders: Cast iron or steel, for introducing chemicals into system; with funnel, shutoff valve on top, air release valve on top, drain valve on bottom, and recirculating shutoff valves on sides.

1. Capacity: 2 quarts (1.9 L).
2. Working Pressure: 175 psi (1210 kPa).

2.3 CHEMICAL TREATMENT TEST EQUIPMENT

A. Kits: As recommended by water treatment system manufacturer for determining water hardness and water characteristics, including carrying case and spare reagents. Provide the following test kits:

1. Alkalinity titration.
2. Chloride titration.
3. Sulfite titration.
4. Total hardness titration.
5. Low phosphate.
6. Conductivity bridge, range 0 to 10,000 microhms.
7. Creosol red pH slide complete with reagent.
8. Portable electronic conductivity meter.
9. High nitrite.

2.4 CHEMICALS

A. Furnish chemicals recommended by water treatment system manufacturer for treating water to meet specified water quality. Provide only chemicals that are compatible with piping materials, seals, and accessories.

B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

C. Biocide: Chlorine release agents or micro-biocides.

D. Closed System (Water) Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install treatment equipment level and plumb, according to manufacturer's written instructions, rough-in drawings, the original design, and referenced standards.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to equipment to allow servicing and maintenance.
2. Hot and Chilled Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping."

B. Electrical: Conform to applicable requirements of Division 26 Sections for connecting electrical equipment.

1. Install electrical devices furnished with boiler but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Provide the services of a qualified independent testing agency to perform field quality-control testing.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

B. Ensure that system is operational, filled, started, and vented prior to cleaning. Place terminal control valves in OPEN position during cleaning. Use water meter to record capacity in each system.

C. Add cleaning chemicals as recommended by manufacturer.

1. Hot-Water Heating System: Apply heat while circulating, slowly raising system to design temperature; maintain for a minimum of 12 hours. Remove heat and allow to cool; drain and refill with clean water. Circulate for 6 hours at design temperature, then drain. Refill with clean water and repeat until system cleaner is removed.
2. Chilled-Water System: Circulate for 48 hours, then drain. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed.

3.5 COMMISSIONING

A. Startup Services: Provide the services of a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Startup Procedures: During boiler system startup, operate boiler water treatment system (after charging with specified chemicals) to maintain required steady-state characteristics of feedwater.

3.6 DEMONSTRATION

A. Provide services of supplier's technical representative for half a day to instruct Owner's personnel in operation, maintenance, and testing procedures of boiler water treatment system.

B. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

C. Review data in the operation and maintenance manuals.

D. Schedule training with Owner, through the Design Professional, with at least 7 days' advance notice.

END OF SECTION 232500

SECTION 233113

METAL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes rectangular and round metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 4 inches to plus 10 inches water gage.

1.3 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract.

B. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Duct Liner.
2. Sealing Materials.

C. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire-rated and other partitions.

7. Terminal unit, coil, and humidifier installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

D. Coordination drawings for ductwork installation in accordance with Division 23 Sections. In addition to the requirements specified, show the following:

1. Coordination with ceiling suspension members.
2. Spatial coordination with other systems installed in the same space with the duct systems.
3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

F. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices.

G. Maintenance data for volume control devices, fire dampers, and smoke dampers.

1.6 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

C. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.

B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

C. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.

D. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

A. General: Comply with NFPA Standard 90A.

B. Materials: ASTM C 1071, Type II, with coated surface exposed to airstream to prevent erosion of glass fibers.

1. Thickness: 1 inch.
2. Density: 1-1/2 pounds.
3. Thermal Performance: "K-Factor" equal to 0.28 or better, at a mean temperature of 75 deg F.
4. Fire Hazard Classification: Flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM C 411.
5. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C 916.
6. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.
   a. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.
   b. Adhesive for Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

2.3 SEALING MATERIALS

A. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for class 1 ducts.

B. Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.

C. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.

B. Hangers: Galvanized sheet steel, or round, zinc plated steel, threaded rod.

1. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
2. Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1995 Edition, for sheet steel width and gage and steel rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
2. For stainless steel ducts, provide stainless steel support materials.
3. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

2.5 RECTANGULAR DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
3. Square throat, round heel elbows shall not be used.

2.6 STATIC PRESSURE CLASSIFICATION

A. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

1. Low Pressure Supply Ducts: 1-inch water gage.
2. Spiral Medium Pressure Supply Ducts (VAV): 10 inches water gage.
3. Rectangular Medium Pressure Supply Ducts (VAV): 6 inches water gage.
4. Return Ducts: 1-inch water gage, negative pressure.
5. Low Pressure Exhaust Ducts: 1-inch water gage, negative pressure.

B. Cross-breaking or Cross Beading: Cross-break or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

2.7 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1995 Edition, Figures 2-1 through 2-10.

2.8 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

E. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

1. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.

F. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

G. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

1. Fan discharge.
2. Intervals of lined duct preceding unlined duct.
3. Upstream edges of transverse joints in ducts.

H. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

I. Perforated Inner Liner: Construct inner liners with perforated 28 gauge sheet metal. Provide 3/32-inch diameter perforations with an overall open area of 23 percent.

2.9 MEDIUM PRESSURE ROUND AND FLAT OVAL DUCT FABRICATION

A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.

B. Round Ducts: Fabricate round supply ducts with spiral lock-seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.

C. Flat Oval Ducts: Fabricate flat oval supply ducts with standard spiral lock-seams (without intermediate ribs) or with butt-welded longitudinal seams in gages listed in SMACNA "HVAC Duct Construction Standards," Table 3-4.

D. Double-Wall (Acoustic) Ducts: Fabricate double-wall insulated ducts with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on double wall ducts are nominal inside dimensions.

1. Thermal Conductivity: 0.27 Btu/sq.ft./deg F/inch thickness at 75 deg F mean temperature.
2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation, and in gages specified above for single-wall duct.
3. Insulation: Unless otherwise indicated, provide 1-inch-thick fiber-glass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the inner liner diameter.
4. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gages listed below. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."
5. Perforated Inner Liner: Construct round and flat oval inner liners with perforated sheet metal of the gages listed below. Provide 3/32-inch-diameter perforations, with an overall open area of 23 percent. For flat oval ducts, the diameter indicated below is the "basic round diameter."
   a. 3 to 8 inches: 28 gage with standard spiral construction.
   b. 9 to 42 inches: 28 gage with single-rib spiral construction.

c. 44 to 60 inches: 26 gage with single-rib spiral construction.
d. 62 to 88 inches: 22 gage with standard spiral construction.

6. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

2.10 ROUND AND FLAT OVAL DUCT SUPPLY AND EXHAUST FITTINGS FABRICATION

A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 1995 Edition, Figures 3-4 and 3-5 and with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.
   a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.
   b. Round Mitered Elbows: Spot welded and bonded with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:
      1) 3 to 26 inches: 24 gage.
      2) 27 to 36 inches: 22 gage.
      3) 37 to 50 inches: 20 gage.
      4) 52 to 60 inches: 18 gage.
      5) 62 to 84 inches: 16 gage.
   c. Round Mitered Elbows: Spot welded and bonded with metal thickness listed below for pressure classes from 2 inches to 10 inches:
      1) 3 to 14 inches: 24 gage.
      2) 15 to 26 inches: 22 gage.
      3) 27 to 50 inches: 20 gage.
      4) 52 to 60 inches: 18 gage.
      5) 62 to 84 inches: 16 gage.
   d. Flat Oval Mitered Elbows: Spot welded and bonded with the same metal thickness as longitudinal seam flat oval duct.
   e. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vanes.
2. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
3. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
4. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
5. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gage with 2-piece welded construction.

6. Round Gored Elbows Gages: Same as for non-elbow fittings specified above.
7. Flat Oval Elbows Gages: Same as longitudinal seam flat oval duct.
8. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gage.

D. Double-Wall (Acoustic) Fittings: Fabricate double-wall insulated fittings with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.

1. Thermal Conductivity: 0.27 Btu/sq.ft./deg F/inch thickness at 75 deg F mean temperature.
2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation. Gages for outer shell shall be same as for uninsulated fittings specified above.
3. Insulation: Unless otherwise indicated, provide 1-inch-thick fiber-glass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.
4. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gages listed below. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."
5. Perforated Inner Liner: Construct round and flat oval inner liners with perforated sheet metal of the gages listed below. Provide 3/32-inch-diameter perforations, with an overall open area of 23 percent. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."
   a. 3 to 34 inches: 24 gage.
   b. 35 to 58 inches: 22 gage.
   c. 60 to 88 inches: 20 gage.
6. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

2.11 TYPE B GAS VENTS

A. Description: Double-wall gas vents, conforming to NFPA 211, Type B. Inner pipe of sheet aluminum, outer pipe of galvanized steel sheet, each with the following minimum thicknesses:

1. Round, 6-Inch Inside Diameter and Smaller: 0.012-inch inner pipe, 0.0187-inch outer pipe.
2. Round, 7 to 18-Inch Inside Diameter: 0.014-inch inner pipe, 0.0187-inch outer pipe.
3. Round 20- to 24-Inch Inside Diameter: 0.018-inch inner pipe, 0.0217-Inch outer pipe.

B. Accessories: Tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, firestop spacers, and fasteners, fabricated of similar materials and designs as vent pipe straight sections.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.

B. Install ducts with the fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

H. Install insulated ducts with 1-inch clearance outside of insulation.

I. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

J. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

K. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

L. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

M. Low pressure supply duct takeoffs shall be equivalent to Crown 306 or equal by Flexmaster or United McGill. Medium pressure takeoffs shall be conical type.

N. Low pressure round duct runouts to supply diffusers may be "snap-lock" duct meeting the pressure classification.

3.2 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints as follows:

1. Conditioned Spaces:
   a. Supply duct pressure classification 2-inches water gage and greater and exhaust ducts: All transverse joints and longitudinal seams.
   b. Supply duct pressure classification less than 2-inches water gage and all return duct: All transverse joints and longitudinal seams.
   c. Return and Exhaust Duct: Al transverse joints and longitudinal seams.
2. Unconditioned Spaces:
   a. Supply duct pressure classification 2-inches water gage and greater: All transverse joints, longitudinal seams, and duct wall penetrations.
   b. Supply duct pressure classification less than 2-inches water gage and all return duct: All transverse joints, and longitudinal seams.
   c. Return and Exhaust Duct: All transverse joints.
3. Outdoor Spaces:
   a. All supply and return duct: All transverse joints, longitudinal seams, and duct wall penetrations.
   b. Exhaust Duct: All transverse joints.

B. Solvent based sealant shall only be used in applications where freezing may occur before sealant is cured. Water-based sealant shall be used in all other applications.

C. Seal externally insulated ducts prior to insulation installation.

D. All duct sealing shall be in accordance with ASHRAE standard 90.1.

3.3 HANGING AND SUPPORTING

A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Chapter 5.

B. Support horizontal ducts within 2-feet of each elbow and within 4-feet of each branch intersection.

C. Support vertical ducts at a maximum interval of 16 feet and at each floor.

D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

E. Install concrete insert prior to placing concrete.

F. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.4 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Duct Accessories."

B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-7 and 2-8.

C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-16 through 2-18.

D. Terminal Units Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-19.

E. Low pressure round supply duct takeoffs shall be equivalent to Crown 306 adjustable 45 degree takeoff. Other acceptable manufacturers include, but are not limited to, Flexmaster and United McGill.

3.5 FIELD QUALITY CONTROL

A. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.

B. All ductwork shall be approved by the Design Professional prior to the application of external insulation. In the absence of such approval, smoke testing, pressure testing or other leakage testing of ductwork shall be required.

C. Determine leakage from entire medium pressure system or section of the system by relating leakage to the total system airflow capacity.

D. The following systems shall be pressure tested in accordance with SMACNA's HVAC Air Duct Leakage Test Manual, and meet the stated criteria:

1. Medium pressure supply ductwork: test at 4.5 inches water column static pressure, with a maximum allowable leakage rate of 0.5%.

E. Do not pressurize systems above the maximum design operating pressure (static pressure classification.) Give 7 days' advanced notice for testing.

F. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage. Integrity of ductwork shall be approved by the Design Professional prior to application of insulation.

3.6 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "TESTING, ADJUSTING, AND BALANCING" for requirements and procedures for adjusting and balancing air systems.

B. Vacuum ducts systems prior to final acceptance to remove dust and debris.

END OF SECTION 233113

SECTION 233300

DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Manual volume control dampers.
2. Fire and smoke dampers.
3. Duct silencers.
4. Turning vanes.
5. Duct-mounted access doors and panels.
6. Flexible connectors.
7. Flexible ducts.
8. Accessories hardware.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract.

B. Product data including details for materials, dimensions of individual components, profiles, and finishes for the following items:

1. Manual volume control dampers.
2. Fire and smoke dampers.
3. Duct-mounted access panels and doors.
4. Duct silencers.
5. Flexible ducts.

C. Shop drawings from manufacturer detailing assemblies. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail the following:

1. Special fittings and volume control damper installation (both manual and automatic) details.
2. Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installations.

D. Product Certification: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static pressure loss, and dimensions and weights.

E. Maintenance data for volume control devices, fire dampers, and smoke dampers

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

B. U.L. Listing: Pre-insulated, outdoor ductwork shall meet U.L. 181, U.L. 723, and U.L. 94 Standards.

1.5 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect items from damage during shipping, storage and handling.

B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME CONTROL DAMPERS

A. General: Provide factory-fabricated volume-control dampers, complete with required hardware and accessories. Stiffen damper blades to provide stability under operating conditions. Provide locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Provide end bearings or other seals for ducts with pressure classifications of 3 inches or higher. Extend axles full length of damper blades. Provide bearings at both ends of operating shaft.

B. Standard Volume Control Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside of air stream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized-steel channels, minimum of 16 gage, and with mitered and welded corners. Provide frames with flanges where indicated for attaching to walls. Provide flangeless frames where indicated for installation in ducts.
2. Roll-Formed Steel Blades: 16-gage galvanized steel.
3. Blade Axles: Galvanized steel.
4. Tie Bars and Brackets: Galvanized steel.

C. Jackshaft: 1-inch-diameter, galvanized-steel pipe or 1/2" square galvanized bar stock rotating within a pipe bearing assembly mounted on supports at each mullion and at each end of multiple damper assemblies. Provide appropriate length and number of mounting to connect linkage of each damper of a multiple damper assembly. Cut groove in the end of the shaft parallel with damper blades.

D. Damper Control Hardware: Zinc-plated, die-cast core with a heavy-gage dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Provide center hole to suit damper operating rod size. Provide elevated platform for insulated duct mounting.

2.2 FIRE DAMPERS

A. General: UL labeled according to UL Standard 555 "Standard for Fire Dampers." Ratings shall be for dynamic system operation at 350º temperature.

1. Dampers used in low pressure systems shall be rated for 2000 fpm velocity and 4" wg pressure.
2. Dampers used in medium pressure systems (VAV supply and medium pressure exhaust) shall be rated for 3000 fpm and 8" wg pressure.

B. Fire Rating: 1-1/2 or 3 hours, as indicated by wall ratings on Architectural Plans.

C. Frame: Type B (blades outside airstream); fabricated with roll-formed, 21-gage, galvanized-steel; with mitered and interlocking corners. Furnish multi-blade dampers where required by code.

D. Mounting Sleeve: Factory-installed or field-installed galvanized steel.

1. Minimum Thickness: 0.056-inch (16-gage) or 0.138-inch (10-gage) thick as indicated, and length to suit application.
2. Exception: Furnish narrow frame damper without sleeve in applications where damper is mounted in rated partition behind supply/return register.

E. Mounting Orientation: Vertical or horizontal as indicated.

F. Blades: Roll-formed, interlocking, 21-gage galvanized steel. In place of interlocking blades, provide full-length, 21-gage, galvanized-steel blade connectors.

G. Fusible Link: Replaceable, 165 deg F rated.

2.3 CEILING FIRE DAMPERS

A. General: UL listed and labeled; comply with the construction details for the tested floor/roof-ceiling assemblies as indicated in the UL Fire Resistance Directory.

B. Frame: 20-gage, rectangular or round, galvanized steel; style to suit ceiling construction.

C. Blades: 22-gage galvanized steel with non-asbestos refractory insulation.

D. Volume Control Adjustment: Provide UL-labeled, fusible volume control adjustment.

E. Fusible Link: Replaceable, 165 deg F rated.

2.4 SMOKE AND FIRE/SMOKE DAMPERS

A. General: UL-labeled according to UL Standard 555S, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems." Combination fire and smoke dampers shall also be UL-labeled for 1-1/2-hour rating according to UL Standard 555 "Standard for Fire Dampers with a Class II leakage rating." Dampers shall be tested at a 350E air temperature.

1. Dampers used in low pressure systems shall be rated for 2000 fpm velocity and 4" wg pressure.
2. Dampers used in medium pressure systems (VAV supply and medium pressure exhaust) shall be rated for 3000 fpm and 8" wg pressure.

B. Fusible Link: Replaceable, 165 deg F rated as indicated (fire/smoke dampers only.)

C. Frame and Blades: 16-gage galvanized steel.

D. Mounting Sleeve: Factory-installed, 18-gage galvanized steel, length to suit wall or floor application.

E. Electric actuator with end switch. All actuators shall be factory mounted outside of the airstream. Furnish damper end switch for control interlocks

2.5 DUCT SILENCERS

A. General: Provide factory-fabricated and -tested round or rectangular silencer with performance characteristics and physical requirements as indicated.

B. Fire Performance: Adhesives, sealers, packing material, and accessory materials shall have fire ratings not exceeding 25 for flame spread and 50 for smoke developed when tested according to ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials."

C. Rectangular Units: Fabricate casings with a minimum of 22-gage solid sheet metal for outer casing and 26-gage perforated sheet metal for inner casing.

D. Round Units: Provide casings with sheet metal thicknesses for the casing diameters as listed below:

1. Up to 24 inches: 22 gage.
2. 26 through 40 inches: 20 gage.
3. 42 through 52 inches: 18 gage.
4. 54 through 60 inches: 16 gage.
5. Casings fabricated of spiral lock seam duct may be 2 gages (one size) lighter than that indicated.
6. Interior Partitions and Baffles: At least 22 gage, and designed for minimum aerodynamic losses.

E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

F. Fibrous Acoustic Fill Material: Inert and vermin-proof fibrous material with density to obtain specified acoustic performance. Pack under not less than 5 percent compression to eliminate voids due to vibration and settling.

G. Nonfibrous Acoustic Fill Material: Moisture-proof, nonfibrous material meeting the acoustic performance requirements.

H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.

1. Do not use nuts, bolts, and sheet metal screws for unit assemblies.
2. Lock form and seal or continuously weld joints.
3. Suspended Units: Provide factory-installed suspension hooks or lugs attached to the frame in quantities and spaced to prevent deflection or distortion.
4. Reinforcement: Provide cross angles or trapeze angles for rigid suspension.

I. Source Quality Control: Perform the following factory tests:

1. Acoustic Performance: Test silencers with airflow in both directions through silencer, according to ASTM E 477, "Methods of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance."
2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels for both forward flow (air and noise in same direction) and reverse flow (air and noise in opposite directions) with an airflow of at least 2,000 FPM face velocity.
3. Leak Test: Test units for airtightness at 200 percent of the associated fan static pressure or 6-inch W.G. static pressure, whichever is greater.

2.6 TURNING VANES

A. Fabricate turning vanes according to SMACNA HVAC Duct Construction Standards, Figures 2-2 through 2-7.

B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, curved blades set at 3/4 inch on center, support with bars perpendicular to blades set at 2 inches on center and set into side strips suitable for mounting in ducts.

C. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fiber glass fill.

2.7 DUCT-MOUNTED ACCESS DOORS AND PANELS

A. General: Provide construction and airtightness suitable for duct pressure class.

B. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.

C. Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of locks as indicated for duct pressure class. Provide vision panel where indicated. Provide cam latches.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.

E. Insulation: 1-inch-thick fiber glass or polystyrene foam board.

2.8 FLEXIBLE CONNECTORS

A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.

B. Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 3rd Edition, Figure 7-8.

C. Conventional, Indoor System Flexible Connectors Fabric: Glass fabric double coated with polychloroprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

D. Conventional, Outdoor System Flexible Connectors Fabric: Glass fabric double coated with Du Pont's HYPALON or other synthetic-rubber weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

2.9 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1.

B. Flexible Ducts - Uninsulated: Spiral-wound steel spring with flameproof vinyl sheathing.

C. Flexible Ducts - Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch-thick, glass fiber insulation around a continuous inner liner.

1. Reinforcement: Steel-wire helix encapsulated in the inner liner.
2. Outer Jacket: Glass-reinforced, silver mylar.
3. Inner Liner: Polyethylene film.
4. Pressure Rating: 10-inches wg, positive.
5. R value = 6.0

D. Woven Polypropylene Hanging Strap:

1. Hanging straps shall be manufactured of woven polypropylene 1¾” wide and having a minimum 400-pound tensile strength.
2. Strap material shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50.
3. Strap material shall be manufactured for flexible HVAC duct support and shall be installed in accordance with the manufacturer’s instructions and SMACNA standards.
4. Straps shall be used on flexible ducts only, and not on rigid ductwork.

2.10 ACCESSORIES HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness.

B. Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch, zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

C. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches to suit duct size.

D. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards.

B. Install volume control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.

C. Provide test holes at fan inlet and outlet and elsewhere as indicated.

D. Install fire and smoke dampers according to the manufacturer's UL-approved printed instructions.

E. Install fusible links in fire dampers.

F. Label access doors according to Division 23 Section "Mechanical Identification."

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233300

SECTION 233423

POWER AND GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations.

B. Operating Limits: Classify according to AMCA 99.

C. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.

1. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
2. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound power ratings.
3. Motor ratings and electrical characteristics plus motor and electrical accessories.
4. Material gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

D. Coordination Drawings, according to Division 23 sections for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling. Show the following:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

F. Maintenance data for power ventilators to include in the operation and maintenance manual.

1.5 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

D. NEMA Compliance: Provide components required as part of fans that comply with applicable NEMA standards.

E. UL Standard: Provide power ventilators that comply with UL 705.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements. Verify clearances.

B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

1.7 COORDINATION AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish one set of belts for each belt-driven fan that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carnes Co.
2. Cook (Loren) Co.
3. Greenheck Fan Corp.
4. Hartzell
5. Penn

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

C. Housing: Removable, galvanized steel, mushroom-domed top; square, one-piece, hinged, aluminum base with venturi inlet cone.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust air stream.

F. Accessories: The following items are required as indicated:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent. Dial-type controller for EC Motors.
2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.
   a. Configuration: Built-in raised cant and mounting flange.
   b. Over-all Height: 12 inches above roof surface.

2.3 MOTORS

A. Refer to Division 23 sections for general requirements for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B. Furnish premium efficiency motors for all above 1 horsepower.

C. Enclosure Type: The following features are required as indicated:

1. Open drip-proof motors where satisfactorily housed or remotely located during operation.
2. Guarded drip-proof motors where exposed to contact by employees or building occupants.

2.4 FACTORY FINISHES

A. Sheet Metal Parts: Prime coat before final assembly.

B. Exterior Surfaces: Baked-enamel finish coat after assembly.

C. Aluminum Parts: No finish required.

2.5 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required as indicated:

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the power ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install power ventilators according to manufacturer's written instructions.

B. Support units using the vibration-control devices indicated. Vibration-control devices are specified in Division 23 Sections.

1. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. Furnish a minimum of one screw per side of the curb.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23.

3.3 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Electrical: Conform to applicable requirements in Division 26 Sections.

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 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, and to report results in writing.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.6 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.7 COMMISSIONING

A. Final Checks before Startup: Perform the following operations and checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
7. Disable automatic temperature-control operators.

B. Starting procedures for fans are as follows:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
2. Measure and record motor voltage and amperage.

C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

E. Replace fan and motor pulleys as required to achieve design conditions.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in the operation and maintenance manuals.

C. Schedule training with Owner, through the Design Professional, with at least 7 days' advance notice.

D. Demonstrate operation of power ventilators.

END OF SECTION 233423

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SECTION 233600

AIR TERMINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Single-duct air terminals.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating air outlets with other items installed in ceilings.

D. Maintenance Data: List of parts for each type of air terminal and troubleshooting maintenance guide to include in the maintenance manual.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered.

B. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

C. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

D. Comply with NFPA 70 for electrical components and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:

1. Acutherm.
2. Air System Components; Krueger Div.
3. Carrier Corp.
4. Environmental Technologies.

5. Johnson Controls
6. Nailor Industries Inc.
7. Metal*Aire
8. Price
9. Titus.
10. Trane Co. (The).

2.2 SINGLE-DUCT AIR TERMINALS

A. Configuration: Volume-damper assembly inside unit casing. Locate control components inside protective metal shroud.

B. Casings: Steel or aluminum sheet metal of the following minimum thicknesses:

1. Upstream Pressure Side: 0.0239-inch steel.
2. Downstream Pressure Side: 0.0179-inch steel.
3. Upstream Pressure Side: 0.032-inch aluminum.
4. Downstream Pressure Side: 0.025-inch aluminum.

C. Casing Lining: Minimum of 1/2-inch-thick, neoprene- or vinyl-coated, fibrous-glass insulation; 1.5-lb/cu. ft. density, complying with NFPA 90A requirements and UL 181 erosion requirements. Secure lining to prevent delamination, sagging, or settling.

1. Coat liner surfaces and edges with erosion-resistant coating or cover with perforated metal.
2. Cover liner with perforated metal.
3. Cover liner with Mylar film.
4. Cover liner with Tedlar film.

D. Plenum Air Inlets: Round stub connections for duct attachment.

E. Plenum Air Outlets: S-slip and drive connections.

F. Access: Removable panels to permit access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.

G. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: 1 percent of nominal airflow at 4-inch wg inlet static pressure.
2. Damper Position: Normally open.

H. Hot-Water Heating Coil: 1/2-inch copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.

I. Controls: Damper operator, thermostat, and other devices compatible with temperature controls specified in other Division 23 Sections.

J. DDC (digital) Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor provide control with the following features:

1. Proportional plus integral control of room temperature.
2. Time-proportional reheat-coil control.
3. Occupied/unoccupied operating mode.
4. Remote reset of airflow or temperature set points.
5. Adjusting and monitoring with portable terminal.
6. Communication with temperature-control system specified in other Division 23 Sections.
7. Controller furnished by the control systems vendor, installed at the air terminal factory prior to shipment to the job site.

2.3 SOURCE QUALITY CONTROL

A. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."

B. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards; and maintain sufficient clearance for normal service and maintenance.

B. Connect ductwork to air terminals according to Division 23 ductwork Sections.

3.2 CONNECTIONS

A. Install piping adjacent to air terminals to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 sections for connecting heating coils to supply with shutoff valve, strainer, control valve, shutoff valve, and union or flange; and to return with balancing valve and union or flange.

C. Electrical: Comply with applicable requirements in Division 26 Sections.

D. Ground equipment.

1. Tighten electrical connectors and terminals 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.

3.3 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.5 COMMISSIONING

A. Verify that installation of each air terminal is according to the Contract Documents.

B. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.

C. Check that controls and control enclosure are accessible.

D. Verify that control connections are complete.

E. Check that nameplate and identification tag are visible.

F. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals.
3. Schedule training with Owner, through the Design Professional, with at least 7 days' advance notice.

END OF SECTION 233600

SECTION 233713

DIFFUSERS, REGISTERS, GRILLES AND LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, grilles and louvers.

1.3 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

D. Louver: Exterior wall air device which resists the penetration of rain.

1.4 SUBMITTALS

A. Product Data: For each model indicated, include the following:

1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
3. Schedule of diffusers, registers, grilles and louvers indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, grilles and louvers and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics may be considered.

B. NFPA Compliance: Install diffusers, registers, grilles and louvers according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Acceptable manufacturers shall be:

1. Anemostat Products
2. Arrow
3. Carnes Co.
4. Greenheck
5. Hart and Cooley
6. Tuttle and Bailey
7. Krueger
8. J&J
9. Nailor
10. Titus
11. Metal*Aire
12. Vent Products
13. Price
14. Dowco
15. Ruskin

B. All louver face ceiling diffusers shall have four cones and removable cores.

C. All exterior louvers shall be 6-inches deep.

2.2 SOURCE QUALITY CONTROL

A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, grilles and louvers are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, grilles and louvers level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where Design Professional features or other items conflict with installation, notify Design Professional for a determination of final location.

C. Install diffusers, registers, grilles and louvers with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, grilles and louvers to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

A. After installation of diffusers, registers, grilles and louvers, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

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SECTION 234000

BIPOLAR IONIZATION AIR PURIFICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This section describes the design, performance and installation of a bipolar ionization air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.

1.3 REFERENCED CODES & STANDARDS

A. The following codes and standards are referenced throughout. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.

1. ASHRAE Standards 62 & 52
2. National Electric Code NFPA 70
3. UL 867

1.4 QUALITY ASSURANCE

A. The bipolar ionization air purification system shall be a product of an established manufacturer in the USA.

B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

C. Technologies that do not address gas disassociation such as UV lights, powered particulate filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. "Plasma" particulate filters shall not be acceptable.

D. Projects designed using ASHRAE Standard 62.1 IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 or later version to validate acceptable indoor air quality at the quantity of outside air scheduled.

E. The bipolar ionization system shall have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007.

F. The maximum allowable ozone concentration per the UL 867-2007 chamber test shall be 0.001 PPM. The maximum peak ozone concentration per the UL 867-2007 peak test as measured 2 inches away from the output of the bipolar ionization unit shall be no more than 0.0012 PPM. Manufacturers with ozone output exceeding these ozone values shall not be acceptable.

G. Electrical Component Standard: Provide components that comply with NFPA 70 "National Electrical Code."

H. NEMA Compliance: Provide electrical components required as part of filter assembly that are listed and labeled by UL and comply with applicable NEMA standards.

I. Listing and Labeling: Provide electrical components that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.

J. NFPA Compliance: Comply with applicable portions of NFPA 90A and 90B.

1.5 SUBMITTALS

A. Submit manufacturer's technical product data for ion generators including:

1. Schedule of bipolar ionization units indicating model number and quantity of each type required for each application.
2. Submittal sheet for each type of bipolar ionization unit and accessories furnished; indicating construction, dimensions, electrical data, and mounting details.
3. Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 or later version to validate acceptable indoor air quality at the quantity of outside air scheduled (when projects are designed with reduced outside air).
4. Product drawings detailing all physical, electrical and control requirements.

B. Operating & Maintenance Data: Submit O&M data and recommended spare parts list.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of products shall be in factory fabricated shipping cartons. Identify on outside of carton the type of product contained within. Avoid crushing or bending.

B. Store in original cartons and protect from weather and construction work traffic.

C. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.7 WARRANTY

A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of twelve months after shipment or eighteen months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerisa
2. Air Oasis
3. Bioclimatic
4. Global Plasma Solutions (GPS)
5. Plasma Air

2.2 GENERAL

A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit scheduled.

B. All other suppliers of comparable products requesting prior approval shall:

1. Submit a request for prior approval at least 15 days prior to bid date. Requests received after that time will not be considered.

2. In addition, as part of the prior approval request, Bipolar Ionization manufacturers must submit their IAQ calculations that prove conformance to ASHRAE Standard 62.1-2007 or later version with the reduction of outside air to the scheduled values. A letter on the manufacturer's letterhead requesting prior approval must accompany the request for prior approval stating their calculations are ASHRAE compliant. A third-party validation study performed on a previous installation of the same application shall also be included.
3. Submit independent test data from ETL or UL on the ozone chamber test.
4. Submit at least two other end user references in the same application with contact phone number, email, equipment used and application at that facility. Manufacturers not having the above references in similar applications using the same equipment models as proposed on the current project shall not be acceptable.

2.3 BI-POLAR IONIZATION DESIGN & PERFORMANCE CRITERIA

A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a plasma ion generator with bipolar ionization output as described here within.

B. The bipolar ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the bipolar ionization equipment (e.g., mold, bacteria, virus).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Reducing space static charges.
4. Reducing space particle counts.

C. The bipolar ionization system shall operate in such a manner that equal amounts of positive and negative ions are produced. Uni-polar (or single pole) ion devices shall not be acceptable.

1. Airflow rates may vary through the full operating range of a VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
2. Velocity Profile: The air purification device shall not have a maximum velocity profile.

D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions to the air purification system.

E. Ionization Equipment Requirements:

1. Electrode Specifications (bipolar ionization):
   a. Each plasma generator with bipolar ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. Bipolar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time and corrosion.
   b. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.
   c. Ionization output from each electrode shall be a minimum of 5-million ions/cc when tested at 2" from the ion generator.
   d. Manufacturer shall demonstrate that no voltage potential exists due to exposed electrical components in the duct system or plenum.

2. Units Mounted in Airstream:
   a. Bipolar ionization units for fan-mounted and duct-mounted applications shall be brush type needlepoint units.
   b. Each bipolar ionization unit shall be rated for the airflow it will be treating.
   c. The bipolar unit housing is made of acrylonitrile butadiene styrene, contains an LED ionization output-indicator, and an in-line 1 Amp fuse
   d. The unit shall contain two (2) mounting feet such that when mounted, the needlepoint brushes are oriented perpendicular to the flow.
   e. Provide self-cleaning accessories to periodically clean electrodes.
3. Certifications
   a. Bipolar ionization units shall be tested and listed by either UL or ETL according to UL Standard 867 – Electrostatic Air Cleaners.
   b. The operation of the electrodes or bipolar ionization units shall conform to UL 867 with respect to ozone generation.

F. Electrical Requirements:

1. Ion generators shall directly accept voltage provided from the voltage provided from the fan coil unit or air handling unit served. Ion generators requiring a loose transformer or power supply will not be accepted.
2. Wiring, conduit and junction boxes shall be furnished and installed by the electrical contractor within housing plenums and shall be UL and NEC NFPA 70 approved.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.2 ASSEMBLY & INSTALLATION: PLASMA GENERATOR WITH BI-POLAR IONIZATION

A. All equipment shall be assembled and installed with a high level of workmanship to the satisfaction of the Owner and Design Professional.

B. Any material damaged by handling, water or moisture shall be replaced by the mechanical contractor at no cost to the owner.

C. All equipment shall be protected from damage on a daily basis throughout construction.

D. Install electrical devices in accordance with manufacturer’s instructions and with electrical divisions of the specifications.

3.3 COMMISSIONING & TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION 234000

SECTION 23 5233

FINNED WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes gas-fired, finned water-tube boilers for heating hot water.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: Include in the maintenance manuals. Include parts list, maintenance guide, and wiring diagrams for each boiler.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

B. ASME Compliance: Boilers shall bear ASME "H" stamp and be National-Board listed.

C. FM Compliance: Control devices and control sequences according to requirements of FM.

D. I=B=R Compliance: Boilers tested and rated according to the Hydronics Institute's "Testing and Rating Standard for Heating Boilers," with I=B=R emblem on a nameplate affixed to the boiler.

E. IRI Compliance: Control devices and control sequences according to requirements of IRI.

F. Comply with NFPA 70 for electrical components and installation.

1.5 COORDINATION

A. Coordinate size and location of concrete bases.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty, executed by the contractor for the heat exchanger.

1. Warranty Period: Manufacturer's standard, but not less than 10 years from date of Material Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide boilers by one of the following:

1. Lochinvar Corp.
2. Raypak, Inc.
3. Teledyne, Inc; Teledyne Laars, Div.

2.2 COMPONENTS

A. Combustion Chamber Internal Insulation: Interlocking panels of vermiculite refractory insulation, high-temperature cements, mineral fiber, and refractory clay for service temperatures to 2100 deg F.

B. Heat Exchanger: Finned copper tubing with stainless-steel baffles and sealed into bronze, steel, or cast-iron headers with silicone O-ring gaskets; for 160-psig working pressure.

C. Jacket: Galvanized steel with factory-applied baked enamel, insulated with foil-faced, glass fiber insulation.

D. Gas Burner: Stainless-steel burners with adjustable combustion-air supply, gas-pressure regulator, diaphragm gas valves, manual shutoff, thermistor flame-sensing device, and automatic 100 percent safety gas shutoff. Include the following features:

1. Burner Firing: High/low/off.
2. Burner Firing: Modulating.
3. Burner Ignition: Intermittent spark or glow coil.
4. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.
5. Flue-Gas Collector and Draft Hood: Integral with boiler casing.

2.3 BOILER TRIM

A. Safety-Relief Valve: ASME rated, factory set to protect boiler and piping.

B. Gage: Combination water pressure and temperature.

C. Low-Water Cutoff and Inlet Flow Switch: Prevent burner operation when water falls below a safe level or when water flow is low.

D. Operating Controls: Prewired, factory-assembled electric control including pilot safety and thermocouple transformer, 24-V gas valve, manual main and pilot valves, and junction box.

E. Standard operating controls shall include a digital temperature controller with an LCD display to control water temperatures and a safety high limit control. The digital temperature control shall display boiler inlet temperature and boiler outlet temperature as well as individual stage set points and differentials. The digital controller shall have a ±1°F accuracy. The control panel shall have a master switch with an indicating light and sequential and diagnostic indicator lights.

F. Low Temperature Protection Valve: Three-way mixing valve and associated controls to maintain boiler entering water temperature above factory specified minimum temperature.

G. Boiler controller shall be capable of accepting enable and supply temperature setpoint reset commands from the facility management system. Provide auxiliary control devices and interface cards where required.

H. High Limit: Temperature control with manual-reset limits boiler water temperature.

I. Boiler air vent.

2.4 ACCESSORIES

A. Circulator: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, mounted on boiler.

2.5 MOTORS

A. Refer to Division 23 Section "Motors" for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

C. Enclosure Type: Open drip-proof motors where satisfactorily housed or remotely located during operation.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect boilers according to the ASME Boiler and Pressure Vessel Code, Section IV.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine area to receive boiler for compliance with requirements for installation tolerances and other conditions affecting boiler performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install boilers level and plumb, according to manufacturer's written instructions and referenced standards.

B. Install gas-fired boilers according to NFPA 54.

C. Support boilers on 4-inch-thick concrete base, 4 inches larger on each side than base of unit.

D. Install electrical devices furnished with boiler, but not specified to be factory mounted.

3.3 CONNECTIONS

A. Connect gas piping full size to boiler gas-train inlet with union.

B. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

C. Install piping from safety-relief valves to nearest floor drain.

D. Connect breeching to boiler outlet, full size of outlet or as indicated on drawings.

E. Electrical: Comply with applicable requirements in Division 26 Sections.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to supervise the field assembly of components and installation of boilers, including piping and electrical connections. Report results in writing.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Hydrostatically test assembled boiler and piping, according to applicable sections of the ASME Boiler and Pressure Vessel Code.

3.5 CLEANING

A. Flush and clean boilers on completion of installation, according to manufacturer's written instructions.

B. After completing boiler installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's touchup paint.

3.6 COMMISSIONING

A. Engage a factory-authorized service representative to provide startup service.

B. Verify that installation is as indicated and specified.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections. Do not proceed with boiler startup until wiring installation is acceptable to equipment Installer.

C. Complete manufacturer's installation and startup checklist and verify the following:

1. Boiler is level on concrete base.
2. Flue and chimney are installed without visible damage.
3. No damage is visible to boiler jacket, refractory, or combustion chamber.
4. Pressure-reducing valves are checked for correct operation and specified relief pressure. Adjust as required.
5. Clearances have been provided and piping is flanged for easy removal and servicing.
6. Heating circuit pipes have been connected to correct ports.
7. Labels are clearly visible.
8. Boiler, burner, and flue are clean and free of construction debris.
9. Pressure and temperature gages are installed.
10. Control installations are completed.

D. Ensure pumps operate properly.

E. Check operation of pressure-reducing valve on gas train, including venting.

F. Check that fluid-level, flow-switch, and high-temperature interlocks are in place.

G. Start pumps and boilers and adjust burners to maximum operating efficiency.

1. Fill out startup checklist and attach copy with Contractor Startup Report.
2. Check and record performance of factory-provided boiler protection devices and firing sequences.
3. Check and record performance of boiler fluid-level, flow-switch, and high-temperature interlocks.
4. Run-in boilers as recommended or required by manufacturer.

H. Perform the following tests for each firing rate for high/low burners and for 100, 66, and 33 percent load for modulating burners. Adjust boiler combustion efficiency at each firing rate. Measure and record the following:

1. Gas pressure on manifold.
2. Combustion-air temperature at inlet to burner.
3. Flue-gas temperature at boiler discharge.
4. Flue-gas carbon-dioxide and oxygen concentration.
5. Natural flue draft.

I. Measure and record water flow rate, pressure drops, and temperature rise through each boiler.

J. Inspect expansion tank, makeup water meter, tank pressure, pressure-reducing valve, water level, and backflow preventer.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
   a. Review data in the maintenance manuals.
3. Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 235233

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SECTION 236426

ROTARY-SCREW CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, rotary-screw water chillers.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each chiller, including chiller refrigerant, chiller capacity, condenser pressure drop, cooler pressure drop, weights (shipping, installed, and operating), furnished accessories, and electrical characteristics.

C. Shop Drawings showing fabrication and installation of chillers, including plans, elevations, sections, details of components, attachments, and other construction elements. Include the following:

1. Dimensions.
2. Weight loadings and distribution.
3. Clearances for maintenance and operation.
4. Size and location of field connections.

D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

E. Coordination Drawings showing the following:

1. Structural supports and pads
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements. Determine spaces reserved for electrical equipment.
4. Access requirements around other work, including working clearances to mechanical controls and electrical equipment.

F. Maintenance data for each chiller to include in the operation and maintenance manual.

G. Certification of performance and factory test results specified in "Source Quality Control" Article.

1.4 QUALITY ASSURANCE

A. ARI Compliance: Rate chiller according to ARI 550.

B. ASHRAE Compliance: Conform to ASHRAE 15 for chiller design, construction, leak testing, and installation.

C. ASME Compliance: Comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for construction and testing of evaporator and condenser pressure vessels. Label evaporator and condenser with ASME mark.

D. NEC Compliance: Comply with applicable NEC requirements for electrical power and control wiring.

E. Refrigerant Exposure: Monitor machine room and sound audible alarm if refrigerant concentrations exceed 10 ppm.

1.5 WARRANTY

A. The special warranty specified in this Article 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.

B. Special Warranty: Submit a written warranty signed by chiller manufacturer and Installer agreeing to furnish parts for compressor and motor failures within special warranty period.

1. Warranty Period: 5 years from date of Material Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide chillers by one of the following:

1. Trane Company (The).
2. United Technologies Corp.; Carrier Corporation Subsidiary.
3. Johnson Controls, Inc.
4. Daiken Corporation.

2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -wired rotary-screw water chiller. Packaged chiller consists of one or more rotary-screw compressors, an evaporator, a condenser that is air cooled, safety controls, and operational controls.

2.3 REFRIGERANT

A. Material: R-134a (HFC-134a); provide full operating charge of refrigerant and oil.

1. Refrigerant Circuit: Provide refrigerant charging port.

2.4 COMPRESSOR

A. Description: Hermetic or semi-hermetic, rebuildable rotary compressor with variable frequency drive capacity control.

2.5 MOTOR

A. Refrigerant-cooled, hermetic induction motor, with the following features:

1. Variable frequency drive motor controller.
2. Overvoltage protection.
3. Undervoltage protection.
4. Single-phasing protection.
5. Current-overload protection.
6. Over temperature due to loss of panel ventilation.

2.6 EVAPORATOR

A. Description: Shell and tube cooler with refrigerant totally enclosed by shell; water in tubes.

B. Shell Material: Carbon-steel plate.

C. Cooler Tubes: Seamless copper; expanded into tube sheets; individually replaceable; externally finned; with standard, removable, carbon-steel water boxes.

1. Internal Finish: Internally ribbed tubes.

D. Refrigerant Working Pressure: 200 psig.

E. Water Side Working Pressure: 150 psig.

F. Insulation: Factory-applied, 3/4-inch-thick, flexible elastomeric insulation. Insulate evaporator, suction lines, and other surfaces where condensation might occur.

2.7 AIR-COOLED CONDENSER

A. Description: Factory assembled, wired, and tested; and consisting of casing, air-cooled condenser coils, fans, and controls integrated with compressor operation.

B. Casing: Weatherproof, constructed of hot-dip galvanized steel with factory-painted finish.

C. Fans: Propeller type, statically and dynamically balanced.

D. Fan Discharge Arrangement: Vertical.

E. Fan Motor: Direct drive, weatherproof, with bearings permanently lubricated, and having built-in current- and thermal-overload protection.

F. Condenser Coil: Copper tubes with mechanically bonded aluminum fins. Furnish condenser coil guards.

G. Safety and Operating Options: Low-ambient operational controls.

2.8 CHILLER OPTIONS

A. Furnish chillers with the following features:

1. Control transformer.
2. Indicating lights for chiller status.
3. Pressure gages.
4. Audible alarm.
5. Sound attenuation package.
6. Architectural Louvered Panel.
7. Chilled Water Reset Controls
8. Integral power disconnect.

2.9 CONTROLS, GENERAL

A. Manufacturer's standard, microprocessor-based chiller controls. Furnish LON or BacNet based interface for full integration with building automation system.

2.10 TEMPERATURE CONTROLS

A. Compressor Capacity Control: Variable frequency drive and modulating slide valve to maintain chilled water temperature set point without hunting within throttling range. Include the following features:

1. Throttling Range: Full load to 10 percent of full load.
2. Chilled water temperature control.
3. Chilled water temperature setback.
4. Load limit controller.

B. HVAC Controls: Furnish appurtenances to monitor and control chilled water set point, to monitor condenser water set point, and to monitor chiller alarms from building's HVAC controls. (Lon or BacNet)

2.11 SAFETY CONTROLS

A. Automatically reset controls to perform the following functions:

1. Low evaporator pressure cutout.
2. Low evaporator temperature cutout.
3. Low chilled water temperature cutout.
4. Low oil sump temperature cutout.
5. Low oil pressure cutout.
6. High oil temperature cutout.
7. High condenser pressure cutout.
8. Water-Flow Interlock: Vapor proof water-flow switch to prevent starting of compressor without chilled water flow.

2.12 POWER CONTROLS

A. Control Panel: Manufacturer's standard, unit mounted, factory wired with a single-point connection, with the following power-control options:

1. External-overload protection.
2. Control circuit fuse.
3. Power terminal block.
4. Lockout restart timer.

B. Variable frequency controller and disconnect with soft start.

2.13 VIBRATION CONTROL

A. Direct isolation (no base) and vibration isolators recommended by manufacturer.

B. Direct isolation and the following vibration isolators specified in other Division 26 Sections.

2.14 SOURCE QUALITY CONTROL

A. Verification of Performance: Test each chiller before shipment. Rate each chiller according to ARI 550, "Standard for Centrifugal or Rotary Water-Chilling Packages." Provide a written report indicating Integrated Part-Load Value (IPLV) at ARI standard conditions or Application Part-Load Value (APLV) and test conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive chillers for compliance with installation tolerances and other conditions affecting performance and maintenance of chillers.

B. Examine proposed route of moving chillers into place and verify that it is free of interferences.

C. Verify piping roughing-in locations.

D. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install chillers according to manufacturer's written instructions.

B. Install chillers plumb and level, and anchor. Anchor housekeeping pads to building floor. Anchor chiller and vibration isolators to housekeeping pad.

C. Install vibration isolators according to isolator manufacturer's written instructions.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install piping connections maintaining clearances for service and maintenance of chillers.

F. Install flange or union connections at chillers.

G. Install flexible pipe connections for chillers.

H. Install shutoff valves at chiller inlet and outlet connections.

3.3 ELECTRICAL CONNECTIONS

A. Refer to Division 26 Sections for wiring devices, wires and cables, and electrical installation requirements.

B. Install and connect remote flow switches and remote chiller control panel.

C. Ground equipment.

1. 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 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise field assembly of components and installation of chillers, including piping and electrical connections, and to report results in writing.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. Clean finishes to remove dust and dirt.

B. Touch up scratches in unfinished surfaces to restore corrosion resistance.

C. Touch up scratches in finished surfaces to restore finish.

3.6 COMMISSIONING

A. Energize chiller and operate controls and safeties.

B. Lubricate rotating parts.

C. Verify that motor amperage conforms to manufacturer's data.

D. Start chiller and verify performance. Demonstrate operation to Owner.

3.7 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to provide startup services and to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel on procedures and schedules related to startup, shutdown, troubleshooting, servicing, and preventive maintenance.

2. Review data in the operation and maintenance manuals.
3. Schedule training with Owner, through the Design Professional, with at least 7 days' advance notice.

END OF SECTION 236426

SECTION 237313

CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes central-station air-handling units with coils, fans, filter racks and accessories.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each central-station air-handling unit specified, including the following:

1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings and electrical characteristics plus motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

E. Coordination Drawings, including floor plans and sections drawn to scale. Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

F. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

G. Maintenance data for central-station air-handling units to include in the operation and maintenance manual.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

B. ARI Certification: Central-station air-handling units and their components shall be factory tested according to the applicable portions of ARI 430, "Central-Station Air-Handling Units," and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute (ARI).

C. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.

D. Comply with NFPA 70 for components and installation.

E. ETL Listing: Each unit shall be ETL listed and labeled.

F. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

G. Coordination: Coordinate layout and installation of central-station air-handling units with piping and ductwork and with other installations.

H. Testing: Each unit shall be test run and thoroughly cleaned at the factory prior to shipping. Airflow test measurements shall be made in accordance with AMCA Standard 203.

I. External static on the air handling unit shall be defined as the static pressure drop external to the unit cabinet. Internal pressure drop shall include the summation of all internal components and cabinet pressure losses. All filters internal to the unit shall be included in the internal pressure drop calculation based on the changeout pressure drops listed below:

Efficiency	Pressure Drop
20-30%	0.5" WG
40-90%	1.0" WG

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver air-handling unit as a factory-assembled module with protective crate and covering.

B. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate size and location of concrete housekeeping bases.

B. Coordinate piping, duct and electrical connections.

C. Coordinate size and location of structural-steel support members with unit shop drawings to insure proper support and orientation.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

B. Filters: Furnish 3 extra sets for each central-station air-handling unit. Spare sets include both prefilter and final filter banks.

C. Fan Belts: Furnish 1 set for each central-station air-handling unit fan.

D. Gaskets: Furnish 1 for each sectional joint of each central-station air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corp.; Carrier Air Conditioning Div.
2. Daikin
3. Johnson Controls, Inc.
4. Trane Company (The); Commercial Systems Group.
5. Temtrol
6. Seasons 4

2.2 MANUFACTURED UNITS

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drain pans, and mixing dampers.

B. Motor and Electrical Components: Refer to Division 23 Section "Motors."

2.3 CABINET

A. Unit casing (wall/floor/pressure bulkhead roof panels and doors) shall be able to withstand up to 1.5 times design static pressure up to 8 inches w.g. in all positive pressure sections and -8 inches w.g. in all negative pressure sections, whichever is less, and shall not exceed 0.0042 inches per inch of panel span (L/240).

B. Floor panels shall be double-wall construction and designed to support a 300-lb. load during maintenance activities and shall deflect no more than 0.0042 inches per inch of panel span.

C. Unit casing panels shall be 2-inch double-wall construction with solid galvanized exterior and solid galvanized or stainless-steel interior to facilitate cleaning of unit interior.

D. Insulation: Shall comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation.

1. The entire unit shall be insulated with R13 closed-cell foam insulation. Structural members shall be insulated similar to the panels.
2. Interior surfaces of insulation shall be completely covered with sheet metal.

E. Access Doors: Same materials and finishes as cabinet and complete with hinges, latches, handles, and gaskets. Double wall construction with stainless steel hinges, perimeter gasket, and door closures.

1. Fan section shall have inspection and access doors sized and located to allow periodic maintenance and inspections. Other doors shall be as shown on the drawings. Fan section door shall be fitted with vision panel.

F. Drain Pans: Formed sections of stainless-steel sheet. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil. Pan shall be sloped for positive drainage to one outlet.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Single point.
3. Units with stacked coils shall have an intermediate stainless-steel drain pan or drain trough to collect condensate from top coil.

G. Lights: Vapor proof movie type light fixture in each accessible section. Furnish exterior light switch for each fixture.

H. Convenience Outlet: Provide 15-amp GFCI receptacle in weatherproof enclosure on exterior of unit.

2.4 FAN SECTION

A. Fan Section Construction: Belt-driven, centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure, equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan scroll, wheel, shaft, bearings, and motor on structural-steel frame, with frame mounted on base with spring-type vibration isolation.

B. Housings: Fabricate from formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.

C. Fan: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor power.

1. Plug Fan: Direct-driven single width single inlet fan consisting of casing and inlet bell, aluminum fan wheel with backward inclined airfoil blades, motor and mountings. Sections with multiple fans shall include integral back-draft dampers for each fan.
2. Shafts: Hot-rolled steel; turned, ground, and polished, and having keyway to secure to fan wheel hub.
3. Shaft Bearings: Pre-lubricated and sealed, self-aligning, pillow-block-type ball or roller bearings with the following:
   a. Rated Bearing Life: ABMA 9 or ABMA 11, L-10 of 100,000 hours.
4. Vibration Control: Install fan/motor assembly on 2” deflection spring vibration isolator with side snubbers.
5. Balancing: Impeller shall be dynamically balanced to ISO 1940 G6.3.
6. Furnish airflow sensing elements in the inlet cones of all fans. Airflow sensing elements are specified under Division 23 “Controls Systems Equipment.”

D. Fan-Section Source Quality Control: The following factory tests are required.

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.5 MOTORS

A. General: Refer to Division 23 Section "Motors" for general requirements.

B. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.

C. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate above 90% of nameplate rating.

D. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.

E. Motor Construction: NEMA MG-1, general purpose, continuous duty, Design B.

F. Bearings: The following features are required:

1. Ball or roller bearings with inner and outer shaft seals.
2. Grease lubricated.
3. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.

G. Enclosure Type: The following features are required:

1. Open drip-proof motors where satisfactorily housed or remotely located during operation.
2. Guarded drip-proof motors where exposed to contact by employees or building occupants.

H. Overload Protection: Built-in, automatic reset, thermal overload protection.

I. Noise Rating: Quiet.

J. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled according to IEEE 112, Test Method B. If efficiency is not specified, motors shall have a higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B.

K. Nameplate: Indicate full identification of manufacturer, ratings, characteristics, construction, and special features.

2.6 COILS

A. Coil Sections: Common or individual, insulated, stainless steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to assure full airflow through coils.

B. Coil Construction: Rigidly supported across full face, pitched to allow drainage.

1. Fins: Aluminum, mechanically bonded to tubes.
2. Tubes: Seamless copper, 5/8" minimum tubing with .025" minimum wall.
3. Coil Casing: Stainless steel.
4. Headers for Water Coils: Steel, cast iron, or copper with connections for drain valve and air vent, and threaded piping connections.
5. Coils shall be leak tested at 150 psig.
6. Chilled water-cooling coils shall be sized such that the face velocity does not exceed 550 feet per minute (fpm.)

C. Water Coils: Drainable with threaded plugs, serpentine with return bends in smaller sizes and with return headers in larger sizes.

D. Coil-Performance Tests: Factory-test cooling and heating coils for rating according to ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

2.7 DAMPERS

A. General: Leakage rate, according to AMCA 500, "Test Methods for Louvers, Dampers and Shutters," shall not exceed 2 cfm per square foot through damper and 4-inch wg pressure differential.

1. Damper operators are specified in Division 23 Section "Control Systems Equipment."

B. Combination Filter/Mixing Box: Parallel-blade galvanized steel damper blades mechanically fastened to steel operating rod in reinforced, galvanized steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Cabinet support members shall hold 2-inch-thick, pleated, flat permanent or throwaway filters. Provide hinged access panels or doors to allow removal of filters from both sides of unit.

2.8 FILTER SECTION

A. Filters: Comply with NFPA 90A.

B. Pre-filter Section: Provide 16 ga. galvanized steel filter media holding frames arranged for flat or angular orientation with filter removal from the entering air side of the frame. Filter shall be 2" deep.

C. Disposable Filters: 2-inch-thick, pleated media in fiberboard cell with metal wire media support, clean airflow resistance of 0.10-inch wg at face velocity of 300 fpm and ASHRAE 52.1 filter-arrestance efficiency of 30 percent.

D. Filter Gauge: Each filter bank shall be fitted with diaphragm type filter gauge with 3-1/2" face, tubing, gauge cocks, static pressure tips and a 0-2" range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of central-station air-handling units.

B. Examine roughing-in of steam, hydronic, condensate drainage piping, and electrical to verify actual locations of connections before installation.

C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install central-station air-handling units level and plumb, according to manufacturer's written instructions. Refer to drawings and Division 23 section “Vibration Isolation” for additional support and vibration isolation requirements.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to air-handling units with flexible connectors.
3. Connect condensate drain pans using Type L copper tubing full size of unit connection. Extend to nearest drain as indicated on the drawings. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
4. Hot- and Chilled-Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff valves, balancing valve and union or flange at each connection.

B. Duct installation and connection requirements are specified in other Division 23 Sections. The

Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

C. Electrical: Conform to applicable requirements of Division 26 Sections.

1. Connect fan motors to wiring systems and to ground. Tighten electrical connectors and terminals 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.
2. Temperature control wiring and interlock wiring is specified in Division 23 Section "Control Systems Equipment."

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

3.6 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

3.7 COMMISSIONING

A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following:

1. Inspect field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Prepare a written report on findings and recommended corrective actions.

B. Final Checks before Startup: Perform the following before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Lubricate bearings, and other moving parts with factory-recommended lubricants.
5. Set outside-air and return-air mixing dampers to minimum outside-air setting.
6. Comb coil fins for parallel orientation.
7. Install clean filters.
8. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.

C. Starting procedures for central-station air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
   a. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.8 DEMONSTRATION

A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

1. Review data in the operation and maintenance manuals.
2. Schedule training with Owner, through the Design Professional, with at least 7 days' advance notice.

END OF SECTION 237313

SECTION 238126

SPLIT SYSTEM HEAT PUMPS AND AIR CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes split system heat pump units and related components.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
2. Refrigerant piping schematics showing sizes and accessories.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

D. Maintenance Data: For equipment to include in the maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver indoor and outdoor units as factory-assembled units with protective crating and covering.

B. Coordinate delivery of units in sufficient time to allow movement into building.

C. Handle units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.6 COORDINATION

A. Coordinate installation of concrete pads and equipment supports.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Material Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Filters: Three sets of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductless Split Systems:
   a. Carrier Corp.
   b. Daikin
   c. Gree Comfort
   d. LG
   e. Mitsubishi
   f. Samsung
   g. Sanyo
   h. Trane

2.2 DUCTLESS SPLIT SYSTEMS

A. Provide a split system heat pump and air conditioning units utilizing outdoor condenser and indoor evaporator connected by copper refrigerant tubing with flare type fittings. Outdoor unit shall contain sufficient R-410a to charge complete system. The condenser shall be equipped with an inverter-driven compressor and external brass service valves and charging port. Indoor unit shall be equipped with electric resistance back-up heater (where indicated.) The outdoor condenser shall have a capillary tube metering device located internally. Evaporator and condenser coils shall be constructed with aluminum fins mechanically bonded to copper tubes. The system shall bear the AHRI Certification symbol.

B. Indoor unit shall be mounted as indicated on the Drawings. Controls shall be integral type IC thermostat with settings for multiple speeds and automatic position, 12-hour timer with ON/OFF settings, night set-back and energy saver position. Furnish hard-wired remote-control panel. Cooling and heating capacities and electrical characteristics shall be as shown on the Drawings.

C. Provide disconnect device for indoor unit when power is supplied by outdoor unit. Furnish low ambient controls and condenser coil guards unless indicated otherwise.

D. Furnish sea-coast protection on outdoor unit.

E. Provide condensate drainage pump with reservoir mounted below wall-hung indoor cassette units. Pump shall be mounted in a factory-made reservoir enclosure and shall be powered from the indoor unit circuit. Pump shall be self-priming. Pump shall be equivalent to the Blue Diamond Microblue with fascia kit, Rector seal Mini White, or Aspen Mini Blanc with opaque reservoirs.

2.3 REFRIGERANT PIPE SIZE

A. Pipe sizes shown on the drawings are for estimating purposes only. Final pipe sizes shall be selected by the manufacturer and shall be included in the submittal data. Accessories (larger crankcase heaters, liquid line solenoid valve, oversize suction accumulators, wind baffles, etc.) required or recommended by the equipment manufacturer shall be provided at no additional cost.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine installation locations for compliance with requirements for conditions affecting installation and performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units according to manufacturer's written instructions.

B. Furnish float switch for unit shutdown interlock.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping to allow service and maintenance.

B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. Furnish flexible connections at all unit connections.

C. Electrical: Conform to applicable requirements in Division 26 Sections.

D. Ground equipment.

1. Tighten electrical connectors and terminals 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. Verify that installation is as indicated and specified.

B. Complete manufacturer's installation and startup checks and perform the following:

1. Level unit on support structure.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
4. Verify that clearances have been provided for servicing.
5. Check that labels are clearly visible.
6. Verify that controls are connected and operable.
7. Remove shipping bolts, blocks, and tie-down straps.
8. Verify that filters are installed.
9. Adjust vibration isolators.
10. Check acoustic insulation.

C. Lubricate bearings on fan.

D. Check fan-wheel rotation for correct direction without vibration and binding.

E. Start unit according to manufacturer's written instructions.

1. Perform starting of refrigeration in summer only.
2. Complete startup sheets and attach copy with Contractor's startup report.

F. Check and record performance of interlocks and protection devices; verify sequences.

G. Operate unit for an initial period as recommended or required by manufacturer.

H. Calibrate thermostats.

I. Check internal isolators.

J. Check controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.

K. Simulate maximum cooling demand and check the following:

1. Compressor refrigerant suction and hot-gas pressures.
2. Short circuiting air through condenser or from condenser to outside-air intake.

L. After starting and performance testing, change filters, vacuum heat exchanger and cooling and condenser coils, lubricate bearings and adjust belt tension.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals.
3. Schedule training with Owner, through the Design Professional, with at least 7 days' advance notice.
4. Provide letter from factory service representative stating that equipment is installed and operating as per manufacturer’s recommendations.

END OF SECTION 238126

SECTION 28219

FAN-COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes fan-coil units with water coils for heating and cooling.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each type of product specified.

C. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Design Professionals and owners, and other information specified.

E. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of fan-coil units.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing fan-coil units similar to those indicated for this Project and that have a record of successful in-service performance.

B. Comply with ARI 440 for testing and rating units.

C. Comply with ASHRAE 33 for testing air coils.

D. Comply with NFPA 70 for components and installation.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

1. Fan-Coil Unit Filters: Furnish three spare filters for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Johnson Controls, Inc.
2. Daikin.
3. United Technologies Corp; Carrier Corp. Div.
4. The Trane Co.

2.2 MATERIALS

A. Chassis: Galvanized steel with flanged edges.

B. Coil Section Insulation: Faced, heavy-density, closed cell insulation over entire section.

C. Drain Pans: Thermo plastic, with connection for drain. Drain pan insulated with closed cell insulation.

D. Cabinet: Galvanized steel with removable panels.

1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge, with safety chain.

E. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer.

2.3 WATER COILS

A. Fin-and-Tube Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 12 fins per inch. Coils shall be burst tested at 450 psig (air) and leak tested at 100 psig (under water.)

2.4 FAN

A. Centrifugal fan, with forward-curved, double-width wheels of galvanized steel, in galvanized steel fan scrolls, directly connected to manufacturer's standard permanently lubricated motor.

2.5 ACCESSORIES

A. Steel subbase, height as indicated.

B. Wiring Terminations: Match conductor materials and sizes indicated. Connect motor to chassis wiring with plug connection.

C. Filters: 1-inch-thick, throwaway filters in fiberboard frames.

D. Electrical Disconnect: Factory mounted.

2.6 DRAIN PAN LEVEL SENSOR SHUTOFF SWITCH

A. Provide a moisture sensor for drain pan to shut off unit should the water level in the drain pan exceed the drain line connection height.

B. Sensor/switch shall be Rector Seal Safe-T-Switch model EP500 or prior approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and supports to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance of fan-coil units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units as indicated, to comply with manufacturer's written instructions and NFPA 90A.

B. Connect fan-coil units and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

C. Connect fan-coil units to hydronic piping according to Division 23 Section "Hydronic Piping." Provide shutoff valve and union or flange at each connection. Connect condensate drain. Install level sensor shut-off switch.

3.3 FIELD QUALITY CONTROL

A. Testing: After installing fan-coil units and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

B. Remove and replace malfunctioning units with new units, and retest.

3.4 CLEANING

A. Replace filters in each fan-coil unit.

3.5 COMMISSIONING

A. Startup Services: Engage a factory-authorized service representative to provide startup service.

B. Operate fan motor to verify proper rotation.

C. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

END OF SECTION 238219

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SECTION 260000

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Division of the specifications (260000) covers the complete interior and exterior electrical system for all work shown on the drawings as specified herein providing all material, labor and equipment required for the installation of the electrical systems complete and in operating condition.

B. Include in the electrical work all the necessary supervision and the issuing of all coordinating information to any other trades who are supplying work to accommodate the electrical installations.

C. Submittal, Record Drawing and Operation and Maintenance Manual Procedures.

1.2 SUBMITTALS

A. HVAC/Plumbing/Electrical Equipment connection coordination letter as noted below:

B. Before submitting shop drawings, Electrical Sub-Contractor shall along with the Mechanical and Plumbing Sub-Contractor review unit locations, unit quantities, unit voltage, phase, MCA and MOCP requirements for mechanical and plumbing equipment to determine the compatibility between what the Mechanical and Plumbing Sub-Contractor is providing and installing versus what is shown in the contract drawings. The Electrical Sub-Contractor shall along with his gear submittals submit a statement that he has reviewed all equipment shop drawings with the Mechanical and Plumbing Sub-Contractors. Any discrepancy between such shall be listed for Engineer review and corrective action. Do not submit the electrical gear without this coordination letter. Contractor is to note that electrical gear submitted without this coordination letter shall not be reviewed, nor returned until Engineer receives such coordination letter.

C. Utility Provider(s) coordination letters.

1.3 COORDINATION

A. This Contractor shall schedule his work and, in every way, possible cooperate with all other Contractors on the job to avoid delays, interferences, and unnecessary work. He shall notify them of all openings, hangers, excavations, etc., so that proper provisions shall be made for his work. This shall not relieve him of the cost of cutting when such is required.

B. This Contractor shall do all cutting and excavating necessary for the complete installation of his work, but he shall not cut the work of any other Contractor without first consulting the

Architect. He shall repair any work damaged by him or his workmen, employing the services of the Contractor whose work is damaged. Saw cut existing slab as required for routing conduits and floor boxes noted to be installed in existing floors. Restore to original finish.

C. This Contractor shall coordinate the location of ceiling lighting fixtures, both recessed and surface mounted, with the Ceiling Contractor so that proper hangers and supports shall be provided.

D. Any conflict between electrical and other trades shall be reported before construction starts. No extra charges will be approved for work resulting from failure to coordinate with other trades.

E. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So, connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

F. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

G. Coordinate sleeve selection and application with selection and application of fire stopping.

1.4 DRAWINGS

A. The drawings for electrical work utilize symbols and schematic diagrams which have no dimensional significance. The work shall, therefore, be installed to fulfill the diagrammatic intent expressed on the electrical drawings.

B. Review architectural drawings for door swings, cabinets, counters, moldings and built-in equipment, conditions indicated on architectural drawings shall govern. Prior to rough-in of receptacles and systems outlets refer to architectural casework drawings for rough-in coordination.

C. Coordinate electrical work with the architectural details, floor plans, elevations, structural and mechanical drawings. Provide fittings, junction boxes and accessories to meet conditions.

D. Do not scale drawings. Dimensions for layout of equipment, or spaces shall be obtained from architectural, structural, or mechanical drawings unless specifically indicated on the electrical drawings.

E. Discrepancies shown on different drawings, between drawings and specifications or between drawings and field conditions shall be promptly brought to the attention of the Architect.

F. Provide as used on the drawings and in the specifications shall mean furnish, install, connect, adjust, and test.

G. The drawings and specifications are complimentary, and any work or material shown in one and omitted in the other or described in the one and not shown in the other, or which may be implied by both or either, shall be furnished as though shown on both, to give a complete and first-class installation.

1.5 CODES AND PERMITS:

A. All electrical work shall meet or exceed the latest requirements of the following codes and/or other authorities exercising jurisdiction over the electrical construction work and the project.

1. The National Electrical Code (NFPA 70) - 2020 Edition
2. The National Electrical Safety Code (ANSI C-2)
3. The Life Safety Code (NFPA 101)
4. The International Building Code
5. Regulations of the local utility company with respect to metering and service entrance.
6. Municipal and State ordinances governing electrical work.

B. All required permits and inspection certificates shall be obtained and made available at the completion of the work. Permits, inspections, and certification fees shall be paid for as a part of the electrical work.

1.6 EQUIPMENT CONNECTIONS:

A. All equipment requiring electrical power connections shall be connected under this Division of these specifications.

B. Where electrical connections to equipment require specific locations, such locations shall be obtained from shop drawings.

C. Drawings for location of conduit stub-up boxes mounted in wall or floor to serve specific equipment shall not be scaled.

D. Electrical circuits to equipment furnished under other sections of these specifications are based on design loads. If actual equipment furnished has loads other than design loads, the electrical circuits and protective devices shall be revised to be compatible with equipment furnished at no additional cost to the Owner. Any revisions must have prior approval by the Architect.

E. Before submitting shop drawings, Electrical Sub-Contractor shall along with the Mechanical and Plumbing Sub-Contractor review unit locations, unit quantities, unit voltage, phase, MCA and MOCP requirements for mechanical and plumbing equipment to determine the compatibility between what the Mechanical and Plumbing Sub-Contractor is providing and installing versus what is shown in the contract drawings. The Electrical Sub-Contractor shall along with his gear submittals submit a statement that he has reviewed all equipment shop drawings with the Mechanical and Plumbing Sub-Contractors. Any discrepancy between such shall be listed for Engineer review and corrective action. Do not submit the electrical gear without this coordination letter. Contractor is to note that electrical gear submitted without this coordination letter shall not be reviewed, nor returned until Engineer receives such coordination letter.

F. Where equipment is indicated to be served thru conduit stub-up, conduit shall be stubbed up not less than four inches above floor where transition shall be made to sealtite flexible conduit for connection to equipment.

G. The Contractor's attention is invited to other Divisions of these specifications, where equipment requiring electrical service or electrically related work is specified to become fully aware of the scope of work required for electrical service or related work.

H. Where electricity utilizing equipment is supplied separate from the electrical work, and is energized, controlled, or otherwise made operative by electrical work, the testing to provide the proper functional performance of such wiring systems shall be conducted by the trade responsible for the equipment. The electrical work shall, however, include cooperation in such testing and the making available of any necessary testing or adjustments to the electrical equipment.

I. Heating, air conditioning, and ventilating equipment is specified to be furnished and installed under other sections of these specifications. The controls likewise are specified to be furnished there under. All necessary wiring, wiring troughs and circuit breakers for power for this equipment shall be furnished and installed under this section of the specifications, in accordance with the plans and/or diagrams furnished with the equipment, or shown on these plans. Starters furnished by the Mechanical Contractor shall be installed under this Division of the specifications. Power wiring to auxiliary equipment on a piece of equipment remote from its main terminal box and interlocking of apparatus shall be accomplished under Heating Ventilating Equipment section of the specifications. Conduit and outlets for control wiring shall be furnished and installed under Division 15 of these specifications. Control conductors for mechanical equipment shall not be installed in same conduit with power conductors.

J. Contractor is to note that location of disconnect switches shown are schematic in nature. Exact location of disconnect switch and mounting height shall be coordinated with field conditions and equipment shop drawings. Locate disconnect as required to maintain clearances required by National Electrical Code.

K. Contractor shall provide a rooftop mounted, GFCI receptacle with weatherproof cover within 20’ of a rooftop mounted HVAC unit. Serve from closest receptacle circuit with ½” C., 3#12’s. See mechanical plan for unit locations.

L. All conduit routed from disconnect to exterior HVAC units shall be routed underground. Turn up adjacent to unit and make transition to sealtite to serve unit. Conduit shall be routed to nearest wall and be concealed in wall. Conduit shall not be installed on grade and sealtite whips from wall to units is not acceptable.

M. All conduit serving rooftop HVAC equipment (rooftop air handler, fans, etc.) shall be concealed in HVAC roof curb. Utilize flexible conduit to routed feeder to service point. Conduits shall not be turned up in individual roof penetrations.

1.7 GUARANTEE:

A. Defective lamps shall be replaced up to date of acceptance and shall be guaranteed for entire length of warranty as specified by the Architect.

B. All systems and component parts shall be guaranteed entire length of warranty as specified by the Architect from the date of final acceptance of the complete project. Defects found during this guaranteed period shall be promptly corrected at no additional cost to the Owner.

1.8 PRODUCT DATA, SAMPLES AND SHOP DRAWINGS SUBMITTAL PROCEDURE

A. Submit for approval by the Architect all materials and equipment to be incorporated in the electrical work.

B. Submit only shop drawings which comply with the contract documents. Shop drawings shall be checked and corrected by the Contractor before they are submitted to the Architect. Shop drawings that are not corrected by the Contractor shall be returned for correction without detailed notations by the Architect as to the necessary corrections.

C. Mark each individual submittal item to show specification section which pertains to the item.

D. Submit information as required under SUBMITTALS, for each of the individual electrical sections of the specifications.

E. Data submitted shall contain all information required to indicate compliance with equipment specified.

F. Submit field information drawings to explain fully all procedures involved in erecting, mounting, and connecting all items of equipment which differ from that specified.

G. When Shop Drawings are reviewed, some errors may be detected but others may be overlooked. This does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Drawings and Specifications shall be followed and are not waived or superseded in any way by the Shop Drawing review.

1.9 RECORD DRAWINGS:

A. One complete set of electrical drawings shall be reserved for as-built drawings. Any approved deviation from the contract drawings shall be recorded on these drawings. Drawings shall be checked monthly for completeness.

B. Completed as-built drawings shall be presented to the Architect prior to final inspection.

1.10 MAINTENANCE AND OPERATING INSTRUCTIONS:

A. Provide at the time of final inspection three sets of maintenance and operating instruction for:
   1. Lighting and Power Panelboards
   2. Fuses
   3. Floor Boxes
   4. Wiring Devices
   5. Lighting Fixtures and Lamps
   6. Lighting Control Panels and Sensors

7. Disconnect Switches
8. Transformers
9. Fire Alarm System
10. Access Control System
11. CCTV Cameras
12. Engine Generator

B. Furnish a qualified and accredited factory trained technician to train personnel designated by the Owner in the proper operation and maintenance of specialized equipment.

C. The issuing of operating instructions shall include the submission of the name, address, and telephone number of the manufacturer's representative and service company for each item of equipment so that service and spare parts can be readily obtained.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Materials specified by manufacturer's name shall be used unless approval of other manufacturers is listed in addenda to these specifications.

B. Drawings indicating proposed layout of space, all equipment to be installed therein and clearance between equipment shall be submitted, where substitution of materials alter space requirements on the drawings.

C. Material Standards: All materials shall be new and shall conform to the standards where such have been established for the material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM)
2. Underwriter's Laboratories, Inc. (UL)
3. National Electrical Manufacturer Association (NEMA)
4. Insulated Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. National Fire Protection Association (NFPA)
7. American National Standards Institute (ANSI)

D. Material of the same type shall be the product of one manufacturer.

E. Materials not readily available from local sources shall be ordered immediately upon approval.

F. The Architect shall have authority to reject any materials, or equipment, not complying with these specifications and have the Contractor replace materials so rejected immediately upon notification of rejection.

G. Any material or equipment so rejected shall be removed from the job within 24 hours of such rejection; otherwise, the Architect may have same removed at the Contractor's expense.

2.2 PRODUCT DELIVERY, STORAGE, HANDLING, & PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and suppliers' recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.

B. All material, except items specifically designed to be installed outdoors such as pad mounted transformers or stand-by generators, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided by the Contractor. Provide temperature and/or humidity control where applicable. No material for interior installation, including conductors, shall be stored other than in an enclosed weather tight structure. Equipment stored other than as specified above shall be removed from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged, or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange, and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Raceways, fixtures, devices, and other electrical equipment shall be installed in a neat and workmanlike manner.

G. The Architect or his representative shall have the authority to reject any workmanship not complying with the contract documents.

H. The Electrical Contractor shall personally or through an authorized licensed and competent electrician, constantly supervise the work from beginning to complete and final inspection.

I. Electrical equipment shall be installed in accordance with manufacturer's recommendations.

J. Locations of proposed raceway, riser, location of structural elements, location and size of chases method and type of construction of floors, walls, partitions, etc., shall be verified before construction starts.

K. Consult owner and utility companies for underground lines before any underground work is started. Contractors shall be responsible for any damage.

L. All empty conduits shall have a pull string installed. All flush recessed boxes shall have blank plates installed.

3.2 CLEANING AND PAINTING

A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touch-up scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.

B. Do not paint trim covers for flush mounted panelboards, telephone cabinets, pull boxes, junction boxes and control cabinet unless required by the Architect. Remove trim covers before painting. Under no conditions shall locks, latches or exposed trim clamps be painted.

C. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.

D. Where plywood backboards are used to mount equipment provided under Division 26, paint backboards with two coats of light grey semi-gloss paint. Plywood shall be 3/4" fire rated plywood. Paint shall be fire retardant paint.

3.3 SERVICE:

A. The electrical service and telephone/CATV service for this project has been coordinated between the Engineer and the Utility Company. However, before installing service conduit (underground or mast), Contractor shall contact Utility Company and verify voltage, location, and type of service. Prior to rough-in, coordinate an on-site meeting with each Utility Company to review exact requirements. Submit letter of coordination to Engineer for review.

B. Where contract documents show a pad mount transformer provide by Utility Company, the following items shall be coordinated with Civil Plans, Architectural Plans, and Utility Company prior to rough-in.

1. Transformer pad locations shall be a minimum of 10’-0” from any building overhangs, canopies, exterior walls, balcony, exterior stairs and or walkways connected to the building.

2. Transformer pad edge shall be no less than 14’-0” from any doorway.
3. Transformer pad edge shall be no less than 10’-0” from any windows or other openings.
4. If the building has an overhang, the 10’-0” clearance shall be measured from a point below the edge of the overhang only if the building is three (3) stories or less. If the building is four (4) stories or more, 10’-0” shall be measured from the outside building wall.
5. Fire escapes, outside stairs, and covered walkways attached to or between buildings, shall be considered part of the building.

    a. Note: This information above has been obtained from the NFPA Section 450-27 and the Office of Insurance and Safety Fire Commissioner Chapter 120-3-3.

6. If required by Utility Company, Contractor shall provide concrete pad for transformer per Utility Company requirements.
7. Contractor shall install meter (provided by Utility Company) on a 6” channel iron set in concrete. Paint channel iron to match transformer. Install 1 ¼” galvanized rigid steel conduit from meter to transformer C.T. compartment.
8. Install a 1 1/4” galvanized rigid steel conduit from meter and stubbed up into Main Electrical Room for future energy management monitoring. Install pull string and cap conduit.

3.4 DEVIATIONS:

A. No deviations from the plans and specifications shall be made without the full knowledge and consent of the Architect or his authorized representative.

B. Should the Contractor find at any time during progress of the work that, in his judgment, existing conditions make desirable a modification in requirements covering any item or items, he shall report such items promptly to the Architect for his decision and instruction.

3.5 EXCAVATION, TRENCHING AND BACKFILLING:

A. General. The Contractor shall perform all excavation to install conduit structures and equipment specified in this Division of the Specifications. During excavation, materials for backfilling shall be piled back from the banks of the trench to avoid over-loading and to prevent slides and cave-ins. All excavated materials not to be used for backfilling shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and other excavations and water accumulating therein shall be removed by pumping. All excavations shall be made by open cut. No tunneling shall be done. All requirements of OSHA shall be complied with.

B. Trench Excavation. The bottom of the trenches shall be graded to provide uniform bearing and support for each section of the conduit on undisturbed soil at every point along its entire length. Over depths shall be backfilled with loose, granular, moist earth, tamped. Removed unstable soil that is not capable of supporting the conduit and replace with specified material.

C. Backfilling. The trenches shall not be backfilled until it is reviewed by the Architect or his representative. The trenches shall be backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, and gravel or soft shale, free from large clods of earth or stones, deposited in 6" layers and tamped until the conduit has a cover of

not less than the adjacent existing ground but not greater than 2" above existing ground. The backfilling shall be carried on simultaneously on both sides of the trench so that conduit is not displaced. The compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material, except that trenches occurring under paved areas or in areas to be filled shall be backfilled in 6" maximum layers and each layer compacted to 95% maximum density. Settling the backfill with water will not be permitted. Any trenches not meeting compaction requirements or where settlement occurs shall have backfill removed down to the top of the conduit then backfill with approved materials as specified hereinbefore.

D. Positively no tree roots are to be damaged, hand dig where required. Damaged trees or shrubbery shall be replaced in kind and must be approved by Engineer.

3.6 FIRESTOPPING

A. Apply fire stopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

3.7 CONSTRUCTION REVIEWS

A. The Architect or his representative shall observe and review the installation of all electrical systems shown on the drawings and as specified herein.

B. Before covering or concealing any conduit below grade or slab, in wall or above ceiling, the contractor shall notify the Architect so that he can review the installation.

3.8 CONTRACTOR'S FINAL INSPECTION

A. Contractor shall refer to individual electrical specification sections for all testing, commissioning, and training requirements specific to each section.

B. At the time of the Contractor's final inspection, all systems shall be checked and tested for proper installation and operation by the Contractor in the presence of the Architect or his representative.

C. The Contractor shall furnish the personnel, tools and equipment required to inspect and test all systems.

D. Following is a list of items that the contractor must demonstrate to the Architect or his representative as complying with the plans and specifications. Please note that this list does not necessarily represent all items to be covered in the final inspection but should give the Contractor an idea of what is to be reviewed.

1. Service ground show connection to ground rod and cold water main.
2. Demonstrate that main service equipment is properly bonded.
3. Demonstrate that all panels have breakers as specified, ground bar, copper bus, typed directory for circuit identification and that they are free of trash.
4. Demonstrate that all conduits are supported as required by the National Electrical Code.

5. Demonstrate that all conductors are providing with correct color coding. This should include all branch circuit neutral conductor striping.
6. Demonstrate that all outlet boxes above or on the ceiling are supported as required by the National Electrical Code.
7. Demonstrate that outlet boxes in wall or ceilings of combustible materials are flush with surface of wall or ceiling, and that outlet boxes in walls or ceilings of non-combustible materials are so installed that the front edge of the box or plaster ring is not set back more than 1/4".
8. Demonstrate that outlet boxes in wall are secure.
9. Demonstrate that all devices are properly secured to boxes, that device plates are properly aligned and are not being used to secure device.
10. Utilizing a Woodhead No. 1750 testing device, demonstrate that all 125-volt receptacles are properly connected.
11. Demonstrate that all fixtures have specified lamps, ballast, and lens, and that they are supported as required by the National Electrical Code or as called for on the drawings or in the specifications.
12. Demonstrate that all disconnects requiring fuses are fused with the proper size and type, and that all disconnects are properly identified.
13. Demonstrate that Fire Alarm System is in proper working order, initiating an alarm signal from each manual and automatic device (including smoke detectors).
14. Demonstrate that the Access Control System is in proper working order.
15. Demonstrate that the CCTV Video Surveillance system is in proper working order.
16. Demonstrate that Engine Generator Set is in proper working order and meeting all requirements outlined in specification.

END OF SECTION

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SECTION 260005

ELECTRICAL SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the preparation of Electrical Division 26 Shop Drawings, Product Data, Samples, and other submittals.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

B. All submittals shall be submitted in electronic format.

C. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into indexed files incorporating submittal requirements of each single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01. A).

3. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software acceptable to Owner**,** containing the following information for EACH SECTION:

    a. Project name.
    b. Date.
    c. Name and address of Architect.
    d. Name of Construction Manager/General Contractor.
    e. Name of Electrical Contractor.
    f. Name of firm or entity that prepared submittal.
    g. Names of subcontractor, manufacturer, and supplier.
    h. Specification Section number and title.

i. Indication of full or partial submittal.

D. Options: Identify options requiring selection by Architect.

E. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

F. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

2.2 SUBMITTAL DATA

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. Mark each copy of each submittal to show which products and options are applicable.
2. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

3. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

4. Submit Product Data before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

D. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER’S ACTION

A. Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it.

B. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

C. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION

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SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Fire-alarm wire and cable.
3. Connectors and splices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. Cerro Wire LLC.
3. Encore Wire Corporation.
4. General Cable; Prysmian Group North America.
5. Okonite Company (The).
6. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

F. Shield:

1. Type TC-ER: Cable designed for use with ASDs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.
2. CommScope, Inc.
3. Comtran Corporation.
4. Genesis Cable Products; Honeywell International, Inc.
5. nVent (PYROTENAX).
6. Prysmian Cables and Systems; Prysmian Group North America.
7. Radix Wire.
8. Rockbestos-Suprenant Cable Corp.
9. Superior Essex Inc.
10. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.

2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: Two hole with standard barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.

a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.

3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is not permitted.
4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inch of slack.

D. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

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SECTION 260526

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Grounding systems and equipment.

B. Section includes grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.

a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. ERICO International Corporation.
3. Harger Lightning and Grounding.
4. ILSCO.
5. O-Z/Gedney; A Brand of the EGS Electrical Group.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches by 12 inches (unless otherwise noted on drawings) in cross section, with 9/32-inchholes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper, or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper, or copper alloy.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

J. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated bolts.

a. Material: Tin-plated aluminum.
b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch in diameter by 10 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Bonding Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.6 LABELING

A. Comply with requirements in Section 260553 "Electrical Identification" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
b. Perform tests by fall-of-potential method according to IEEE 81.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

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SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 SUBMITTALS

A. Product Data: For each type of product including but not limited to:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.
4. Clamps.
5. Hangers.
6. Fasteners.
7. Anchors.
8. Brackets.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Painted Coatings: Manufacturer standard painted coating applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inchin diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 .
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 incheslarger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils

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SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Electri-Flex Company.
4. O-Z/Gedney.
5. Republic Conduit.
6. Robroy Industries.
7. Thomas & Betts Corporation.
8. Western Tube and Conduit Corporation.
9. Wheatland Tube Company.
10. Western Tube

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. FMC: Comply with UL 1; zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT, FMC and LFMC:

    a. Material: Steel.
    b. Type: Provide compression type for two inches (2") and smaller, steel set-screw type for conduits two and half inches (2 ½") and larger.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch with overlapping sleeves protecting threaded joints.

H. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Arnco Corporation.
3. CANTEX Inc.
4. Condux International, Inc.
5. Electri-Flex Company.
6. Heritage Plastics
7. Kraloy.
8. Lamson & Sessions; Carlon Electrical Products.
9. RACO; Hubbell.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 – Interior and Type 3R - Exterior unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
D. Wireway Covers: Screw-cover type unless otherwise indicated.
E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Mono-Systems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.

C. Tele-Power Poles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Mono-Systems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.

2. Material: Galvanized steel with ivory baked-enamel finish.
3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Technologies Company; Cooper Crouse-Hinds.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. FSR Inc.
5. Hoffman.
6. Hubbell Incorporated.
7. Kraloy.
8. Milbank Manufacturing Co.
9. Mono-Systems, Inc.
10. O-Z/Gedney.
11. RACO; Hubbell.
12. Robroy Industries.

13. Thomas & Betts Corporation.
14. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
F. Metal Floor Boxes:

1. Two gang: Wiremold RFB2 – The floor box shall be manufactured from stamped steel and be approved for use on above grade floors. The box shall be 13 1/8" L x 6 1/2" W x 2 5/8" H . There shall be two independent wiring compartments that allow capacity for up to two duplex receptacles and/or communication services. The RFB2-SS Series Box shall permit tunneling from end power compartment to end power compartment. Each of the two compartments shall have a minimum wiring capacity of 38 cu in.. The box shall provide the following number of conduit knockouts: Two 1/2" and twelve 3/4". The box shall be fully adjustable, providing a maximum of 1 3/8" pre-pour adjustment, and a maximum of 3/4" after-pour adjustment. The box shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate Ortronics workstation connectivity outlets and modular inserts, the Pass & Seymour Network Wiring System, and other open system devices. Each floor box shall have an empty 1”C. (with pull string) routed from floor box and stubbed up to above accessible ceiling.

2. Four gang: Wiremold RFB4The floor box shall be manufactured from stamped steel and be approved for use on above grade floors. The box shall be 12 3/4" L x 10" W x 3 7/16" H.There shall be four independent wiring compartments that allow capacity for up to four duplex receptacles and/or communication services. The RFB4 Series Box shall permit tunneling from end power compartment to end power compartment. The RFB4-4DB Series Box shall permit tunneling from adjacent or opposite compartments. Two of the four compartments shall have a minimum wiring capacity of 16.4 cu in. , one compartment shall have a minimum capacity of 32.3 cu in. , and one compartment shall have a minimum capacity of 50 cu in. . The box shall provide the following number of conduit knockouts: one 1/2" , three 1" , six 3/4" , and six 1 1/4" . The box shall be fully adjustable, providing a maximum of 1 7/8" pre-pour adjustment, and a maximum of 3/4" after-pour adjustment. The box shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate Ortronics workstation connectivity outlets and modular inserts, the Pass & Seymour Network Wiring System, and other open system devices. Each floor box shall have an empty 1.5”C. (with pull string) routed from floor box and stubbed up to above accessible ceiling.

3. Audio Visual Floor boxes: FSR FL-500P-6 (basis of design unless otherwise noted on the drawings for all AV floorboxes) Floor box shall be heavy gauge steel, 10" x 12" x 6" nominal dimensions, and shall be UL listed. Designed for installation in carpeted concrete floors. Floor box shall contain 3 separately partitioned cavities capable of accommodating 1 single-gang, 1 two-gang brackets, and one four-gang bracket. Floor boxes shall have 8 or more knockouts in trade sizes varying from 0.5" to 1.25" spaced uniformly on the sides and ends. Floor boxes shall have screw-attached, disposable, heavy gauge metal covers. Floor box shall have an 11 gauge finished cover. Location as shown on drawings,

any significant variance (more than 9") in location of any floor boxes Electrical Contractor is directed to notify Architect. Coordinate finish with Architect and/or Owner.

4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep
K. Gangable boxes are prohibited.
L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 – Interior and Type 3R – Exterior; with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 1 – Interior and Type 3R – Exterior;] galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. NewBasis.
d. Oldcastle Precast, Inc.
e. Quazite: Hubbell Power System, Inc.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, Coordinate exact lettering based on usage such as - "ELECTRIC", “COMMUNICATIONS”, “TELEPHONE”.
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC, EMT, RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT, Type EPC-40-PVC to 48”AFF.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 1/2-inchtrade size.
D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Steel compression type for two inches (2") and smaller, steel set-screw type for conduits two and half inches (2 ½") and larger. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.
F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
B. Keep raceways at least 6 inchesaway from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
C. Complete raceway installation before starting conductor installation.
D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
H. Support conduit within 12 inches of enclosures to which attached.
I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inchtrade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-footntervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inchtrade size and insulated throat metal bushings on 1-1/2-inchtrade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

O. Cut conduit perpendicular to the length. For conduits 2-inchtrade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inchesof slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Q. Communication System (Data/Voice) Conduits

1. Backboxes: All wall outlet boxes shall be, 4" x 4" x 2 1/8" deep square a with single gang plaster ring (unless otherwise noted). Plaster rings shall be flush with finish of wall. Coordinate depth of plaster ring required with type of wall construction.
2. Conduit: Each data or voice outlet shall have a 1" conduit routed from the flushed recessed outlet box up to the accessible ceiling space above. Turn conduit out above ceiling with a 90° horizontal elbow and terminate with an insulated bushing. Where ceiling finish is exposed structure (i.e. no acoustical tile ceiling), extend conduit to an area with an accessible gypboard/acoustical ceiling. Provide nylon pull string in conduit.
3. Provide 302 jumbo stainless steel blank wall plates for all outlets not cabled.

R. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg Fand that has straight-run length that exceeds 25 feet Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg Fand that has straight-run length that exceeds 100 feet
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg Fof temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg Fof temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

B. Install manufactured rigid steel conduit elbows for stub-ups at all switchboards, panelboards, service transformers, poles, and equipment at all building floor penetrations.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
   c. All rigid steel conduit elbows shall be wrapped with Scotchwrap #50 corrosion protection tape.

C. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inchsieve to No. 4sieve and compacted to same density as adjacent undisturbed earth.
C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
D. Install handholes with bottom below frost line below grade.
E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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SECTION 260544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Division 7 Section "Through-Penetration Firestop Systems" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

   a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."
   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 260553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels, including arc-flash warning labels.
8. Miscellaneous identification products.

1.2 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.3 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes and standards. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Colors for 480/277-V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

4. Color for Neutral: Multi-wire branch circuit Dedicated Neutral: White (120/208V) and Gray (277/480V) with appropriate tracer (i.e -gray with brown tracer, gray with orange tracer, gray with yellow tracer)
5. Color for Equipment Grounds: Green.
6. Colors for Isolated Grounds: Green with white stripe.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

F. Equipment Identification Labels:

1. Black letters on a white field.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.4 FLOOR MARKING TAPE

A. 2-inch-wide, 5-milpressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.6 WARNING LABELS AND SIGNS

A. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

B. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a black background. Minimum letter height shall be 3/8 inch

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

H. Painted Identification: Comply with requirements in Division 9 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. Lighting
4. Fire Alarm System

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

a. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.

H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inc high letters for emergency instructions at equipment used for power transfer.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master

units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inchigh letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Directory shall note room numbers of spaces served. Panelboard identification shall be engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Switchboards.
    d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    e. Emergency system boxes and enclosures.
    f. Enclosed switches.
    g. Enclosed circuit breakers.
    h. Push-button stations.
    i. Power transfer equipment.
    j. Contactors.
    k. Remote-controlled switches, dimmer modules, and control devices.
    l. Power-generating units.
    m. Monitoring and control equipment.
    n. UPS equipment.
    o. Disconnect switches

END OF SECTION

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SECTION 260923

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Photoelectric switches.
2. Indoor occupancy sensors.
3. Switchbox-mounted occupancy sensors.
4. Digital timer light switches.
5. Emergency shunt relays.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

E. Sample Warranty: For manufacturer's warranties.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Products supplied shall be from a single manufacturer that has been continuously involved in manufacturing of occupancy sensors for a minimum of five years. Mixing of manufacturers shall not be allowed.

C. All components shall be U.L. listed, offer a five year warranty and meet all state and local applicable code requirements.

1.4 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.

2. Leviton Mfg. Company Inc.

3. Paragon Electric Co.; Invensys Climate Controls.

4. TORK.

B. Description: Solid state, with dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.

2. Time Delay: 15-second minimum, to prevent false operation.

C. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.

1. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Building Automation.
2. Leviton Mfg. Company Inc.
3. Cooper Controls
4. Watt Stopper.
5. Acuity Controls

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inchknockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc keep lighting off when selected lighting level is present.
8. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
9. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.

10. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

11. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.

12. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

13. All sensors shall have UL rated, 94V-0 plastic enclosures.

C. PIR Type: Wall/Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or a comparable product from the listed manufactures:

a. Watt Stopper: CX-100

2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

3. Detection Coverage (Rooms, High Ceilings): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

4. Detection Coverage (Corridor, High Ceilings): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.

D. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or a comparable product from the listed manufactures:

a. Watt Stopper: CI-200

2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

3. Detection Coverage (Room, High Ceilings): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

E. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or a comparable product from the listed manufactures:

a. Watt Stopper: WT Series

2. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s

3. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.

4. Detection Coverage (Standard Rooms, Restrooms): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

5. Detection Coverage (Large Room, Restrooms): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.

6. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet

F. Dual-Technology Type: Wall/Ceiling corner mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or a comparable product from the listed manufactures:

a. Watt Stopper: DT-200

2. Sensitivity Adjustment: Separate for each sensing technology.

3. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s

4. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

G. Dual-Technology Type: Ceiling mounting 360 degree coverage; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or a comparable product from the listed manufactures:

a. Watt Stopper: DT-300

2. Sensitivity Adjustment: Separate for each sensing technology.

3. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s

4. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Building Automation.

2. Leviton Mfg. Company Inc.

3. Cooper Controls

4. Watt Stopper.

B. Acuity Controls Acuity Controls General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.

3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.

2. Sensing Technology: Dual technology - PIR and ultrasonic.

3. Switch Type: as shown on drawings

4. Voltage: Match the circuit voltage.

5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 DIGITAL TIMER LIGHT SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Greengate
4. Watt Stopper.

B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.

1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for ballast or LED, and 1/4 horsepower at 120-V ac.
2. Integral relay for connection to BAS.
3. Voltage: Match the circuit voltage.
4. Color: match wiring devices
5. Faceplate: Color matched to switch.

2.5 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Building Automation.
2. Leviton Mfg. Company Inc.
3. Cooper Controls
4. Watt Stopper.
5. Acuity Controls.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924. Compatible with 0-10 volt LED dimmer such that fixtures controlled are brought to 100% output upon emergency operation.

1. Coil Rating: as required.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Division 26 Section "Conductors and Cables."

PART 3 - EXECUTION

3.1 OCCUPANCY SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room at no additional cost.

C. It is the contractor’s responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.

D. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

C. Lighting control devices that fail tests and inspections are defective work.

3.6 FACTORY COMMISSIONING

A. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system.

B. Upon completion of the system fine tuning the factory authorized technician shall provide the proper training to the owner's personnel in the adjustment, operation and maintenance of the sensors.

C. The electrical contractor shall provide the manufacturer, owner, architect and the electrical engineer with ten working days written notice of the scheduled commissioning date.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Controls."

END OF SECTION

SECTION 262200

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20 and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

C. Interior Enclosures: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Exterior Enclosures: Ventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

F. Taps for Transformers Smaller than 3 kVA: None.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor. K-factor shall be K=13.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

M. Wall Brackets: Manufacturer's standard brackets as required.

N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 20 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Floor mounted transformers: Install transformers on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 3 Section.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For transformers, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor. Provide rubber isolation (to mitigate vibration noise) between concrete pad and transformer base.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts required for proper attachment to transformer.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Key interlock scheme drawing and sequence of operations.

1.3 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 24 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; by Schneider Electric.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    b. Outdoor Locations: NEMA 250, Type 3R.
    c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.

2. Height: 84 inches maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware. Eaton/Cutler Hammer – “EZ Trim” is not acceptable.
4. Finishes:

    a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Galvanized steel.

G. Incoming Mains:

1. Location: Top and/or bottom, as required for configurations shown on drawings.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

    a. Plating shall run entire length of bus.
    b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

J. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices.

K. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: Ten percent.

L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS

A. Panelboards: NEMA PB 1, distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Mains: Circuit breaker or Lugs only, as indicated on drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker or lugs only, as indicated on drawings.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

    a. RMS sensing.
    b. Field-replaceable rating plug or electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.
    e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    f. Integral test jack for connection to portable test set or laptop computer.
    g. Field-Adjustable Settings:

        1) Instantaneous trip.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings..
    d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    g. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
    i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.

j. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
n. Multipole units enclosed in a single housing with a single handle.
o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
p. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. BREAKER APPLICATION

1. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

a. 400A frames and below: Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
b. 450 A frames and larger: Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s), 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 3 Section.
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inches above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch empty conduits from all flush mounted panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Straight-blade convenience, isolated-ground, and tamper-resistant receptacles.
2. USB charger devices.
3. GFCI receptacles.
4. Twist-locking receptacles.
5. Pendant cord-connector devices.
6. Toggle switches.
7. Wall-box dimmers.
8. Wall plates.
9. Floor service outlets.
10. Poke-through assemblies.
11. Service poles.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
c. Leviton Manufacturing Co., Inc (Leviton).
d. Pass & Seymour/Legrand (Pass & Seymour).

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.3 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, Specification Grade, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and FS W-C 596.

B. Tamper-Resistant Convenience Receptacles, Specification Grade, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498, and FS W-C-596.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, Specification Grade, 125 V, 20 A:

C. Tamper-Resistant GFCI Convenience Receptacles, Specification Grade, 125 V, 20 A:

2.5 USB CHARGER DEVICES

A. Tamper-Resistant, USB Charger Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.

1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles: Dual, Type A or C as designated.
3. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A, Specification Grade:

1. Single pole switches: Hubbell 1221.

2. Double pole switches: Hubbell 1222.
3. Three way switches: Hubbell 1223.
4. Four way switches: Hubbell 1224.

2.9 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider or push button with single-pole or three-way switching. Comply with UL 1472.

C. LED: 120/277 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices.
2. 2000 W; dimmers shall required no derating when ganged with other devices.
3. 0-10 Volt, Dimmer For L.E.D. Fixtures. Provide Purple and Pink class 2, 600 Volt Rated, #18 AWG TFN solid copper control 0-10 Volt Control Wiring For All L.E.D. Fixtures where controlled by low-voltage controllers or wall box dimmers.

2.10 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch-hick, satin-finished stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant , die-cast aluminum with lockable cover.

2.11 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: **Architect to Select**, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles [**up**] [**down**], and on horizontally mounted receptacles to the [**right**] [**left**].

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 262813

FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, enclosed controllers and motor-control centers.
2. Spare-fuse cabinets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Fuse sizes for elevator feeders and elevator disconnect switches.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01782 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.

3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Motor Branch Circuits: Class RK1, time delay.
2. Other Branch Circuits: Class RK1, time delay .
3. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Electrical Identification" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

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SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Molded-case circuit breakers (MCCBs).
3. Enclosures.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg Fand not exceeding 104 deg F
2. Altitude: Not exceeding 6600 feet

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.2 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices.

C. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Electrical Identification."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

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SECTION 263213

PACKAGED ENGINE GENERATOR

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
   1. Gas engine.
   2. Unit-mounted cooling system.
   3. Unit-mounted control and monitoring.
   4. Outdoor enclosure.

B. Related Sections include the following:
   1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Thermal damage curve for generator.
   2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
   2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   3. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For installer and manufacturer.

D. Source quality-control test reports.
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
4. Report of sound generation.
5. Report of exhaust emissions showing compliance with applicable regulations.
6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four Insert number hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles Insert number of miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with UL 2200.

I. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature: 5 to 40 deg C.
   2. Relative Humidity: 0 to 95 percent.
   3. Altitude: Sea level to 1000 feet .

1.6 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 5 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
   2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
   3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar; Engine Div.
   2. Kohler Co.; Generator Division.
   3. Onan/Cummins Power Generation; Industrial Business Group.
   4. Generac.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated on drawings.
   2. Output Connections: Three-phase, four wire.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:
   1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
   2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
   3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
   4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
   6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
   8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:
   1. Natural Gas:

      a. Carburetor
      b. Secondary Gas Regulators: One for each fuel type.
      c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
      d. Flexible Fuel Connectors: One for each fuel source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
   4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
   5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

      a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 12-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice times without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
      b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
      c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
      d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
      e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
      f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
   1. AC voltmeter.
   2. AC ammeter.
   3. AC frequency meter.
   4. DC voltmeter (alternator battery charging).
   5. Engine-coolant temperature gage.
   6. Engine lubricating-oil pressure gage.
   7. Running-time meter.
   8. Ammeter-voltmeter, phase-selector switch(es).
   9. Generator-voltage adjusting rheostat.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

F. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

G. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Button shall be located on building at exterior of main electrical room. Push button shall be protected from accidental operation.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
   1. Tripping Characteristic: Designed specifically for generator protection.
   2. Trip Rating: Matched to generator rating.
   3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
   4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent, maximum.

2.7 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
   1. Minimum sound attenuation of 25 dB at 500 Hz.

2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads of up to 100 mph.

C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Hinged Doors: With padlocking provisions.

E. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

F. Muffler Location: Within enclosure.

G. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2.8 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Material: Bridge-bearing neoprene, complying with AASHTO M 251.
2. Durometer Rating: 65.
3. Number of Layers: Two.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.
   8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
   9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Electrical Supports and Seismic Restraints."

D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 15 Section "Hydronic Piping."
   1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 15 Section "Hydronic Piping."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Natural- and LP-gas piping, valves, and specialties for gas distribution outside the building are specified in Division 2 Section "Natural Gas Distribution."
   2. Natural- and LP-gas piping, valves, and specialties for gas piping inside the building are specified in Division 15 Section "Fuel Gas Piping."

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to Division 15 Section "Mechanical Identification" and Division 26 Section "Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for

Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
7. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
8. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line , and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

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SECTION 263600

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Remote annunciation systems.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Qualification Data: For manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain all transfer switches and remote annunciators through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 110.

G. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.4 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:

a. Caterpillar; Engine Div.
b. Emerson; ASCO Power Technologies, LP.
c. Kohler Power Systems; Generator Division.
d. Onan/Cummins Power Generation; Industrial Business Group.
e. Generac.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Service-Rated Transfer Switch:

1. Comply with UL 869A and UL 489.
2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
3. In systems with a neutral, the bonding connection shall be on the neutral bus.
4. Provide removable link for temporary separation of the service and load grounded conductors.
5. Surge Protective Device: Service rated.
6. Ground-Fault Protection: Comply with UL 1008 for normal bus.
7. Service Disconnecting Means: Externally operated, manual mechanically actuated.

H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: General-purpose NEMA 250, Interior - Type 1, Exterior - 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.
6. Main and Neutral Lugs: Mechanical type.
7. Ground bar.
8. Connectors shall be marked for conductor size and type according to UL 1008.

C. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

G. Automatic Transfer-Switch Controller Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches both ATS Switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Electrical Supports and Seismic Restraints."

B. Annunciator Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Division 26 Section "Electrical Identification."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 264113

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes lightning protection for structures.

B. The new lighting protection system for new additions shall be connected to the existing system and labeled as one system.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

C. Field quality-control reports.

D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.
2. LPI System Certificate.
3. UL Master Label Recertification.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, **Class II**, aluminum unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. East Coast Lightning Equipment Inc.
b. ERICO International Corporation.
c. Harger.
d. Heary Bros. Lightning Protection Co. Inc.
e. Independent Protection Co.
f. Preferred Lightning Protection.
g. Robbins Lightning, Inc.
h. Thompson Lightning Protection, Inc.

2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.

3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.

C. Main and Bonding Conductors: Aluminum.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.

F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

G. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches from building foundation.
2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION

SECTION 264313

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Corporation.
2. Emerson Electric Co.
3. GE Zenith Controls.
4. PowerLogics, Inc.
5. Schneider Electric Industries SAS.
6. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 2.

1. SPDs with the following features and accessories:

a. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
b. Indicator light display for protection status.

c. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
d. Surge counter.

C. Comply with UL 1283.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 480 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V
2. Line to Ground: 1200 V for 480Y/277 V
3. Line to Line: 2000 V for 480Y/277 V

F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 1000 V.
3. Line to Line: 1000 V.

G. SCCR: Equal or exceed 200 kA.

H. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Corporation.
2. Emerson Electric Co.
3. GE Zenith Controls.
4. LEA International; Protection Technology Group.
5. Schneider Electric Industries SAS.
6. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 2.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of

any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V 1200 V for 208Y/120 V

F. SCCR: Equal or exceed 200 kA.

G. Inominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

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SECTION 265116

LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior luminaires, lamps, and ballasts.
2. Luminaire supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. IP: International Protection or Ingress Protection Rating

D. Lumen: Measured output of lamp and luminaire, or both.

E. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Ballast, including BF.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Include photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
7. Air and Thermal Performance Data: For air-handling luminaires. Furnish data required in "Action Submittals" Article in Section 233713 "Diffusers, Registers, and Grilles."
8. Sound Performance Data: For air-handling luminaires. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory is accredited under the NVLAP for Energy Efficient Lighting Products.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.7 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. LED Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598.

D. Nominal Operating Voltage: Multivolt.

E. Recessed Luminaires: Comply with NEMA LE 4.

2.2 LED LUMINARIES

A. CRI of minimum 80.

B. Rated lamp life of 50,000 hours.

C. Lamps dimmable from 100 percent to 0 percent of maximum light output.

D. Internal driver. Provide with standard 0-10V dimming.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY".
b. CCT and CRI for all luminaires.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish shall match luminaire.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

F. Ceiling-Grid-Mounted Luminaire Supports: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inches from luminaire corners. Provide a minimum of two wires on opposite corners of fixture
2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

G. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

H. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

I. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing, rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

B. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

   1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

C. Luminaire will be considered defective if it does not pass operation tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

   1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
   2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

SECTION 271100

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
3. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of **Registered Technician**, who shall be present at all times when Work of this Section is performed at Project site.

3. Field Inspector: Currently registered by BICSI as **RCDD Commercial Installer, Level 2** to perform the on-site inspection.

PART 2 - PRODUCTS

2.01 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in "Rough Carpentry."

2.02 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.

2. Cooper B-Line.

3. Hubbell Premise Wiring.

4. Leviton Commercial Networks Division.

5. Middle Atlantic Products, Inc.

6. Ortronics, Inc.

7. Panduit Corp.

8. Siemon Co. (The).

9. Tyco Electronics Corporation; AMP Products.

B. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

2. Material: Extruded aluminum.

3. Finish: Manufacturer's standard, baked-polyester powder coat.

4. Color: Black

2.03 19-INCH EQUIPMENT RACKS

A. Description: **Two** post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.

B. Floor-Mounted Racks:

1. Overall Height: **72 inches**.

2. Overall Depth: **23 inches**.

3. Upright Depth: **6 inches**.

4. Four-Post Load Rating: **1000 lb**.

5. Number of Rack Units per Rack: **As indicated on Drawings**.

6. Threads: Universal square.

7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.

8. Base shall have a minimum of four mounting holes for permanent attachment to floor.

9. Top shall have provisions for attaching to cable tray or ceiling.

10. Self-leveling.

C. Cable Management:

1. Metal, with integral wire retaining fingers.

2. Baked-polyester powder coat finish.

3. Vertical cable management panels shall have front and rear channels, with covers.

4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.04 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Rack mounting.

3. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.

4. LED indicator lights for power and protection status.

5. LED indicator lights for reverse polarity and open outlet ground.

6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.

7. Cord connected with 15-foot line cord.

8. Rocker-type on-off switch, illuminated when in on position.

2.05 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.

3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

2.06 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.02 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.03 FIRESTOPPING

A. Comply with requirements in Division 7 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.04 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.05 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

END OF SECTION

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SECTION 271300

COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. UTP cable.

2. [**50/125**] [**62.5/125**]-micrometer, optical fiber cabling.

3. Coaxial cable.

4. Cable connecting hardware, patch panels, and cross-connects.

5. Cabling identification products.

B. Related Sections:

1. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.03 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.04 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. Cabling administration drawings and printouts.

3. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.

b. Patch panels.

c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development] by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of **Registered Technician**, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: **25** or less.

2. Smoke-Developed Index: **50** or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use **optical loss test set**.

2. Test each pair of UTP cable for open and short circuits.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Inc.; Electronics Division.

2. Berk-Tek; a Nexans company.

3. CommScope, Inc.

4. Draka USA.

5. Genesis Cable Products; Honeywell International, Inc.

6. KRONE Incorporated.

7. Mohawk; a division of Belden CDT.

8. Nordex/CDT; a subsidiary of Cable Design Technologies.

9. Superior Essex Inc.

10. SYSTIMAX Solutions; a CommScope Inc. brand.

11. 3M.

12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, **100**-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket **and overall metallic shield**.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, **Category 6**.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    a. Communications, General Purpose: Type CM or CMG.
    b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    d. Communications, Limited Purpose: Type CMX.
    e. Multipurpose: Type MP or MPG.
    f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.02 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
    1. American Technology Systems Industries, Inc.
    2. Dynacom Corporation.
    3. Hubbell Premise Wiring.
    4. KRONE Incorporated.
    5. Leviton Voice & Data Division.
    6. Molex Premise Networks; a division of Molex, Inc.
    7. Nordex/CDT; a subsidiary of Cable Design Technologies.
    8. Panduit Corp.
    9. Siemon Co. (The).
    10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: **110-style IDC for Category 6**. Provide blocks for the number of cables terminated on the block, plus **25** percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: **One** for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair [UTP cable indicated] [conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria].

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, 4-pair cables in **36-inch length**; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.03 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Berk-Tek; a Nexans company.

2. CommScope, Inc.

3. Corning Cable Systems.

4. General Cable Technologies Corporation.

5. Mohawk; a division of Belden CDT.

6. Nordex/CDT; a subsidiary of Cable Design Technologies.

7. Optical Connectivity Solutions Division; Emerson Network Power.

8. Superior Essex Inc.

9. SYSTIMAX Solutions; a CommScope Inc. brand.

10. 3M.

11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, **62.5/125**-micrometer, **24** fiber, **nonconductive,** tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.

2. Comply with **TIA/EIA-492AAAA-A** for detailed specifications.

3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG.

    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

    c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.

    d. General Purpose, Conductive: Type OFC or OFCG.

    e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.

    f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

4. Conductive cable shall be **aluminum** armored type.

5. Maximum Attenuation: **3.50** dB/km at 850 nm; **1.5** dB/km at 1300 nm.

6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.04 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.

2. American Technology Systems Industries, Inc.

3. Berk-Tek; a Nexans company.

4. Corning Cable Systems.

5. Dynacom Corporation.

6. Hubbell Premise Wiring.

7. Molex Premise Networks; a division of Molex, Inc.

8. Nordex/CDT; a subsidiary of Cable Design Technologies.

9. Optical Connectivity Solutions Division; Emerson Network Power.

10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: **One** for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

2. Quick-connect, simplex and duplex, **Type LC** connectors. Insertion loss not more than 0.75 dB.

3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.05 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.06 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.07 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceways and Boxes."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

10. In the communications equipment room, install a 10-foot-long service loop on each end of cable.

11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.

2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.

2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than **60 inches** apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.04 FIRESTOPPING

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.05 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

1. Administration Class: **2**.

2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 9 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for **Class 2** level of administration.

D. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, **backbone pathways and cables, entrance pathways and cables,** terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

   a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.

   b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

   1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.

   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

   3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

      a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

   4. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 271500

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Coaxial cable.
3. Multiuser telecommunications outlet assemblies.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.
7. Cable management system.

B. Related Sections:

1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.03 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

1.04 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration.

D. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawingsby an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [25] or less.
2. Smoke-Developed Index: [50] or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.07 DELIVERY, STORAGE, AND HANDLING

1. Test each pair of UTP cable for open and short circuits.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: [One] of each type.
2. Connecting Blocks: [One] of each type.
3. Device Plates: [Five] of each type.
4. Multiuser Telecommunications Outlet Assemblies: [One] of each type.

PART 2 - PRODUCTS

2.01 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated.
7. Mohawk; a division of Belden CDT.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand.
11. 3M.
12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG
b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
c. Communications, Riser Rated: Type CMR complying with UL 1666.
d. Communications, Limited Purpose: Type CMX
e. Multipurpose: Type MP or MPG
f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
g. Multipurpose, Riser Rated: Type MPR **or MPP**, complying with UL 1666.

2.02 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
9. Siemon Co. (The).
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 10 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

1. Number of Terminals per Field: One for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair for UTP cable indicated

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.03 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Provide ports as indicated on drawings

1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

3. Legend: Machine printed, in the field, using adhesive-tape label.

2.04 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.05 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Electrical Identification."

2.06 CABLE MANAGEMENT SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. iTRACS Corporation.
2. Telsoft Solutions.

B. Description: Computer-based cable management system, with integrated database capabilities.

C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.

2.07 SOURCE QUALITY CONTROL

A. Factory test UTP cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceways and Boxes."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.02 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for UTP at least 49 feet from communications equipment room.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than [**60 inches**] apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.03 FIRESTOPPING

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.04 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.05 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 9 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and

destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments,and inspect cabling connections for compliance with TIA/EIA-568-B.1.

2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

    a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.

6. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3
7.
8. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

    a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
    b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

END OF SECTION 271500

SECTION 280513

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. RS-232 cabling.
2. RS-485 cabling.
3. Low-voltage control cabling.
4. Control-circuit conductors.
5. Fire alarm wire and cable.
6. Identification products.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

F. RCDD: Registered Communications Distribution Designer.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.

b. Minimum bending radius.

c. Maximum pulling tension.

B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Allowable pulling tension of cable.
2. Cable connectors and terminations recommended by the manufacturer.

1.04 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: **25** or less.
2. Smoke-Developed Index: **50** or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1.06 PROJECT CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 UTP CABLE AND HARDWARE

A. Comply with Division 27 “Communications horizontal cabling”

2.02 OPTICAL FIBER CABLE and OPTICAL FIBER CABLE HARDWARE

A. Comply with Division 27 “Communications backbone cabling”

2.03 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. 1 pair, twisted No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.04 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.05 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Comtran Corporation.

2. Draka Cableteq USA.

3. Genesis Cable Products; Honeywell International, Inc.

4. Rockbestos-Suprenant Cable Corp.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.

2. Line-Voltage Circuits: No. 12 AWG, minimum.

3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor **with outer jacket** with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.06 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.

2. HellermannTyton.

3. Kroy LLC.

4. PANDUIT CORP.

5. Encore Wire

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Electrical Identification."

2.07 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

D. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 INSTALLATION OF PATHWAYS

A. Comply with requirements in Division 26 Section "Raceways and Boxes" for installation of conduits and wireways.

3.02 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for installation of supports for pathways, conductors and cables.

3.03 WIRING METHOD

A. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Install cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.04 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).

    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.05 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. Signaling Line Circuits: Power-limited fire alarm cables **may** be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.06 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Division 26 Section "Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.

2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.

3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.07 CONNECTIONS

A. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Division 28 Section "Digital Addressable Fire- Alarm System" for connecting, terminating, and identifying wires and cables.

3.08 FIRESTOPPING

A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

B. Comply with TIA-569-B, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.09 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding."

3.10 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

3.11 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

D. Prepare test and inspection reports.

END OF SECTION

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SECTION 281000

ACCESS CONTROL AND DURESS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control system.
2. Duress System
3. Video Intercom System

1.2 DEFINITIONS

A. DGP: Data gathering panel.

B. NFC: Near field communications.

C. REX: Request-to-exit.

D. DPS: Door Position Switch (Door Contact)

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site

B. Preinstallation Coordination Meeting(s): For access control. Conduct meeting(s) on project site prior to installation:

1. Attendees: Installers, county staff, sheriff's office staff, and Architect

1.4 APPROVED SUPPLIER AND INSTALLER

A. South Western Communications, INC. Decatur, AL (no equals nor alternate vendors)

1.5 ACTION SUBMITTALS

A. Shop Drawings:

1. Project general notes.
2. Head-end hardware, equipment, and device locations.
3. Block diagram and cable/conduit routing illustrating end-to-end system wiring.
4. End-to-end system communications details.
5. Secondary power calculations

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
.
1. Printing, programming, and handling instructions for access control credentials.
2. Installation instructions for access control remote devices.
3. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
4. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
5. Manufacturer's recommended tests and inspections for access control remote devices.

B. Warranty documentation.

1.7 WARRANTY FOR ACCESS CONTROL SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed access control system performs in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: [**Two**] years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of access control system perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: [**Three**] years from date of Substantial Completion; [**prorated**] coverage for labor, materials, and equipment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM

A. Description: Access control system provides a means of regulating or controlling physical entry into an area, or access to or use of a device by electrical, electronic, and/or mechanical means. Typical access control system includes a card reader at a controlled door, which reads a user credential and sends the collected data to a centrally located DGP over the cabling infrastructure. DGP may hold a user database onboard or may communicate with a user database over the network. If user is authorized for access at a controlled door, DGP signals the electronic lock at the door to unlock. If user credential is not authorized according to user database, the door remains locked and access is denied. In addition to card readers and electronic locks, access control systems may include various other connected devices programmed for a desired function.

B. Performance Criteria:

1. Regulatory Requirements:

a. Components listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria: UL CCN ALOV and UL CCN ALVY; including UL 294.
3. Consult Architect for resolution of conflicting requirements.

C. Selection of Access Control System Components:

1. Source Limitations: Obtain components for access control system from sources approved by Owner warranting performance of entire system.
2. Provide the following specified products with the access control system:

a. Existing CA4K Access Control System to remain.

b. Access Control System Hardware:

1) System DGP will be provided by owner.
2) ACS door controller(s) will be provided by owner.
3) ACS input/output interface(s) will be provided by owner.
4) Provide and install the following:
   a) General 12DC or 24DC Equipment:
   b) Power Supplies to be Manufactured by Altronix
   c) Field Selectable 12vDC or 24vDC
   d) Single Output per powered device
   e) 7AHR AGM Battery for 12vDC Power Supply; 2x 7AHR AGM Battery for 24vDC Power Supply
   f) Specialized Sargent Electrified Hardware: specific compatible Sargent Power Supplies as required

c. Security Door Hardware:
1) Manufacturer shall be HES; Field Selectable Faile Safe/Fail Secure; Field Selectable 12vDC or 24vDC
2) Delayed-egress electromagnetic lock(s)
3) Electromechanical lock(s)
4) Self-contained electronic lock(s)
5) Exit lock(s) and alarm(s)
6) Auxiliary electrified door hardware.
7) Door operator controls
8) Panic exit device(s) with electric strike

d. Integrated Credential Readers and Entry Management:
1) Proximity reader(s) for card, fob, or smartphone. Manufacturer shall be HID signo series; Multi-Class & Bluetooth capable.

e. Electrified Locking Devices and Accessories:

1) Electrically controlled single-point latch(es)

2) Electrically controlled two-point latch(es)
3) Electrically controlled three-point latch(es)
4) Type 1 high-security electronic lock(s)
5) Type 1F high-security combination lock(s)
6) Type 2 high-security combination lock(s)
7) REX motion sensor(s)
8) REX push-button(s)

f. Egress Management Devices:

1) Magnetic lock hardware with special locking arrangement

2) Panic hardware with special locking arrangement

g. Intercom Entry Systems:

1) Shall be AiPhone IXG series. Coordinate with Owner personnel for IP connectivity and landing locations.

D. Special Techniques:

1. Comply with manufacturer's published instructions.
2. Mounting Heights: Mount field devices in accessible locations in accordance with United States Access Board ADA-ABA Accessibility Guidelines standards.
3. Wiring Methods:
   a. Access Control
      1) Backbone Cable Type: CAT6A
      2) Cable Type: Access Control Composite cable with minimum: AWG 22/6 shielded, AWG 18/4, AWG 22/4, AWG 22/2. Exterior Composite Cable Color shall be yellow. Plenum rated.
      3) Analog Maximum Cable Length: 500ft
      4) Digital Maximum Cable Length: 300ft

   b. Duress System
      1) Cable Type: AWG 22/4, Color shall be yellow. Plenum rated.
      2) Analog Maximum Cable Length: 500ft

   c. Video Intercom
      1) Outdoor Cable Type:
      2) Digital Maximum Cable Length: 300ft

E. Interfaces with Other Work:

1. Coordinate installation of new access control system components with existing conditions.

2. Coordinate with [for interfacing access control system devices with door hardware.
3. Coordinate with for interfacing access control system with elevator controls.
4. Coordinate with Addressable Fire-Alarm Systems for unlocking secured doors that are in exit ways, with or without delay.
5. Coordinate with Mass Notification for unlocking secured doors that are in exit ways, with or without delay.

6. Coordinate with Detention Monitoring and Control Systems for interfacing access control system with detention monitoring and controls.
7. Coordinate with Chain Link Fences and Gates for interfacing access control system with fence and gate controls.

F. Systems Integration:
1. Coordinate with Section 282000 "Video Surveillance" for integrating access control system with video surveillance controls.
2. AiPhone Gate Intercom System

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM COMPONENTS

A. Acceptance Testing Preparation:

1. Coordinate with Owner personnel.
2. Doors
   a. Proximity reader(s)
      1) Badge Valid
      2) Badge Violate Void
   b. Door Contact
      1) Door Normal
      2) Door Forced
      3) Door Open to Long
   c. Door REX
      1) Trigger unlocks door
      2) Trigger is properly timed to unlock only by those leaving the door
   d. Door Strike/Electrified Hardware
      1) Badge Valid unlocks Door
      2) Remote unlock via Software
      3) Suite lockdown switch

3. Duress
   a. Alarm triggers at Control Room
   b. Alarm triggers at Front Desk
   c. Alarm triggers at Holding Control Room
   d. Labels are correct

4. Video Intercom
   a. Audio Clarity
      1) Control Room
      2) Front Desk
      3) Holding Control Room
   b. Video Clarity
      1) Control Room
      2) Front Desk
      3) Holding Control Room
   c. Gate Control Functional
      1) Control Room
      2) Front Desk
      3) Holding Control Room

B. Field tests and inspections must be witnessed by owner.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for access control system components.
2. Perform industry standard tests and inspections for power supplies, batteries, and other standby power provisions.
3. Engage factory-authorized service representative to test end-to-end system connection and functionality.
4. Verify monitoring of access control system status and diagnostics information.

D. Nonconforming Work:

1. Access control equipment will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports.

3.3 SYSTEM STARTUP

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup check in accordance with manufacturer's published instructions.

2. Coordinate with owner personnel

3.4 ADJUSTING

A. Control Sensor Adjustments: Adjust control devices to suit actual occupied conditions.

1. For proximity motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.5 PROTECTION

A. After installation, protect access control system components from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Control Sensor Readjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in readjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 281000

SECTION 282300

VIDEO SURVEILLANCE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.

1.02 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
4. UPS: Sizing calculations.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Field quality-control reports.

E. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

F. Warranty: Sample of special warranty.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NECA 1.

C. Comply with NFPA 70.

1.05 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity,

condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h). Use NEMA 250, Type 3R enclosures.

5. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM REQUIREMENTS

A. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient Voltage Suppression."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient Voltage Suppression" as recommended by manufacturer for type of line being protected.

C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.02 STANDARD CAMERAS

A. Manufacturers: Subject to compliance with requirements, provide products by the following only.

1. Axis Communications AB. **(No Equals)**

B. Color Camera:
1. Pickup Device: CCD interline transfer, 380,000 **771(H) by 492(V)** pixels.
2. Horizontal Resolution: 480 lines.
3. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
4. With AGC, manually selectable on or off.
5. Manually selectable modes for backlight compensation or normal lighting.

6. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
7. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
8. Motion Detector: Built-in digital.

C. Automatic Color Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, color camera, motorized pan and tilt, zoom lens, and receiver/driver.
1. Pickup Device: CCD interline transfer, 380,000 **768(H) by 494(V)** pixels.
2. Horizontal Resolution: 480 lines.
3. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
4. With AGC, manually selectable on or off.
5. Manually selectable modes for backlight compensation or normal lighting.
6. Pan and Tilt: Direct-drive motor, 360-degree rotation angle, and 180-degree tilt angle. Pan-and-tilt speed shall be controlled by operator. Movement from preset positions shall be not less than 300 degrees per second.
7. Preset Positioning: Eight user-definable scenes, each allowing 16-character titles. Controls shall include the following:

    a. In "sequence mode," camera shall continuously sequence through preset positions, with dwell time and sequencing under operator control.
    b. Motion detection shall be available at each camera position.
    c. Up to four preset positions may be selected to be activated by an alarm. Each of the alarm positions may be programmed to output a response signal.

8. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
9. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
10. Motion Detector: Built-in digital.
11. Dome shall support multiplexed control communications using coaxial cable recommended by manufacturer.

2.03 REINFORCED DOME CAMERAS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Axis Communications AB. **(No Equals)**

B. Camera: Designed for high-abuse locations, with a weathertight **surface** mounting, impact-resistance polycarbonate dome, and heavy-gage, 6061 T6 aluminum body.

1. Suitable for exterior environment, rated for continuous operation in ambient temperatures of minus 40 to plus 122 deg F (minus 40 to plus 50 deg C) dry bulb and up to 85 percent relative humidity.
2. Pickup Device: CCD interline transfer, 290,000 **510(H) by 492(V)** pixels.
3. Horizontal Resolution: 350 lines.
4. Signal-to-Noise Ratio: Not less than 46 dB.
5. With AGC and automatic backlight compensation.
6. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 6 lux at f/2.0.

7. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
8. White Balance: Auto-tracing white balance.

2.04 LENSES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Axis Communications AB

B. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses with color cameras.

1. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
2. Fixed Lens: With calibrated focus ring.
3. Zoom Lens: Motorized, remote-controlled unit, rated as "quiet operating." Features include the following:

a. Electrical Leads: Filtered to minimize video signal interference.
b. Motor Speed: Variable.
c. Lens shall be available with preset positioning capability to recall the position of specific scenes.

2.05 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera[**, infrared illuminator,**] and lens.

1. Enclosure: NEMA 250, Type 1.

2.06 CAMERA-SUPPORTING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Axis Communications AB **(No Equals)**

B. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action, and equipped with matching mounting brackets.

1. Scanning Operation: Silent, smooth, and positive.
2. Stops: Adjustable without disassembly, to limit the scanning arc.

C. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.

1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
3. Speed: 12 degrees per second in both horizontal and vertical planes.
4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.

D. Protective Housings for Fixed and Movable Cameras: **6061 T6 aluminum** enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
1. Camera Viewing Window: **Polycarbonate** window, aligned with camera lens.
2. Duplex Receptacle: Internally mounted.
3. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
4. Built-in, thermostat-activated **blower** units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
5. Sun shield shall not interfere with normal airflow around the housing.
6. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
7. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WIRING

A. Comply with requirements in Division 26 Section "Raceways and Boxes."

B. Wiring Method: Install cables in raceways unless otherwise indicated.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.
3. Conceal raceways and wiring except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. For LAN connection and fiber-optic and copper communication wiring, comply with Division 27 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling."

F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.03 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections only at the control station.

1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.

G. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

a. Prepare equipment list described in "Submittals" Article.
b. Verify operation of auto-iris lenses.
c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.

d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
e. Set and name all preset positions; consult Owner's personnel.
f. Set sensitivity of motion detection.
g. Connect and verify responses to alarms.
h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.06 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION

SECTION 283111

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders.
7. Remote annunciator.
8. Addressable interface device.
9. Digital alarm communicator transmitter.
10. LTE/IP Dual fire alarm communicator

1.02 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.03 SYSTEM DESCRIPTION

A. Noncoded, **UL-certified** addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

1.04 SUBMITTALS

A. General Submittal Requirements:
1. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, **Level III** minimum.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector

housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

E. Qualification Data: For qualified Installer.

F. Field quality-control reports.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

a. Frequency of testing of installed components.
b. Frequency of inspection of installed components.
c. Requirements and recommendations related to results of maintenance.
d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.

H. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm **Level III** technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify **Construction Manager and Owner** no fewer than three days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without **Owner's** written permission.

1.07 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.08 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for **two** years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within **two** years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide **30** days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Siemens Building Technologies, Inc.; Fire Safety Division. **(No Equals)**

2.02 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.

3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Heat detectors in elevator shaft and pit.
8. Fire-extinguishing system operation.
9. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit **and remote annunciators**.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Recall elevators to primary or alternate recall floors.
10. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit **and remote annunciators**. Record the event on system printer.

2.03 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting **and allow for adjustment of sensitivity at fire-alarm control unit**.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, **3** line(s) of **40** characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands **and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters**.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.

a. Initiating Device Circuits: **Style D**.
b. Notification Appliance Circuits: Style Z.
c. Signaling Line Circuits: **Style 5**.
d. Install no more than [**50**] addressable devices on each signaling line circuit.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Notification Appliance Circuit: Operation shall sound.

F. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall.

a. Elevator lobby detectors except the lobby detector on the designated floor.
b. Smoke detector in elevator machine room.
c. Smoke detectors in elevator hoistway.

2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall **be** connected to fire-alarm system.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

I. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided **in a separate cabinet located in the fire command center** or **as a special module that is part of fire-alarm control unit**.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.

a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
b. Programmable tone and message sequence selection.
c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, **supervisory signals and supervisory and digital alarm communicator transmitters** shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: **Sealed lead calcium**.

L. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.04 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, **breaking-glass or plastic-rod pull-lever** type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.05 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be **four**-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated **and power-on status**.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Smoke detectors in duct work shall be photo electric type furnished and connected under Division 16, installation in duct work shall be accomplished under Division 15.
2. Power supply for detectors shall be 24 volts D.C. and supplied from fire alarm control panel.
3. Provide contacts to automatically shut down fan motors.
4. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
5. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
7. Each sensor shall have multiple levels of detection sensitivity.
8. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions were applied.

9. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
10. Provide remote station having LED to indicate alarm condition and key switch to test and reset alarm relay at a readily accessible location for all duct detectors that are not readily accessible.

    a. In mechanical room mount remote station 6'-0" above finished floor.
    b. Where air handling unit or damper is above ceiling, mount remote station in wall below ceiling or in ceiling.

11. Detectors for air handling equipment rated over 2000 CFM, but less than 15,000 CFM shall be located in the supply duct.
12. Location of duct detectors shown is schematic in nature only. Verify exact location with unit and duct work placement.
13. Where duct detector is required to be on building exterior, provide weatherproof detector and 120 volt power as required.
14. Provide control modules at each detector. Modules shall be connected and programmed to close dampers and shunt down air handling units as required to meet building codes. Coordinate sequence of operation with mechanical.

2.06 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of **135 deg F** or a rate of rise that exceeds **15 deg F** per minute unless otherwise indicated.

    1. Mounting: **Twist-lock base interchangeable with smoke-detector bases**.
    2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of **190 deg F**.

    1. Mounting: **Twist-lock base interchangeable with smoke-detector bases**.
    2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.07 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

    1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

C. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

E. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:

a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, [**red**] [**white**].

F. Voice/Tone Notification Appliances:

1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: **surface mounted and bidirectional**.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.08 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.09 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: **Surface** cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture **two** telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on **either** line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. **Address** of the supervisory signal.
3. **Address** of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

E. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed **30 feet**.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than **3 feet** from air-supply diffuser or return-air opening.

6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

K. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.02 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."
   1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

   1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
   2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is[**not**] permitted.
   3. Signaling Line Circuits: Power-limited fire alarm cables [**may**] [**shall not**] be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.03 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Division 26 Section "Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.04 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 8 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.05 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.06 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.07 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction and **Engineer**.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.08 DEMONSTRATION

A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 316615
HELICAL PILE FOUNDATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes helical piles.

1.3 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles from tip to pile top.

B. Work of this Section is affected as follows:

1. Pile Length: Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest 5’ section.
2. Number of Piles: Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for excavation, testing and inspection, and other items for complete pile installation.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles out of specified tolerance or defective piles.

C. Test Piles: Same unit price as indicated for production piles.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. The Contractor shall submit a detailed description of the construction procedures proposed for use to the Owner for review. This shall include a list of major equipment to be used.

C. Shop Drawings: For helical piers shall be prepared by or under the supervision of a qualified professional engineer. Technical submittal shall include the following:

1. Helical pile number, location, and pattern by assigned identification number if not indicated on plan.
2. Load required of each helical pile.
3. Type and size of central steel shaft.
4. Helix configuration (number and diameter of helix plates proposed)
5. Minimum effective installation torque
6. Minimum depth.
7. Helical pile attachment to structure relative to grade beam, column pad, pile cap, etc.

D. The Contractor shall submit shop drawings for all helical pile components, including corrosion protection and pile top attachment to the Owner for review and approval. This includes helical pile lead and extension section identification (manufacturer's catalog numbers).

E. Work shall not begin until all the submittals have been received and approved by the Owner.

1.6 INFORMATIONAL SUBMITTALS

A. Material Certificates: For the following:

1. Central Steel Shaft.
2. Helix Bearing Plate.
3. Bolts
4. Couplings
5. Plates, Shapes or Pier Caps.

1.7 INSTALLATION RECORDS

A. The Contractor shall provide the Owner copies of helical pile installation records within 24 hours after each installation is completed. Formal copies shall be submitted on a weekly basis. These installation records shall include, but are not limited to, the following information:
1. Name of project and Contractor
2. Name of Contractor's supervisor during installation.
3. Date and time of installation
4. Name and model of installation equipment.
5. Type of torque indicator used.
6. Location of helical pile by assigned identification number.
7. Actual central steel shaft type and configuration – included lead section (number and size of helix plates), number and type of extension sections.
8. Helical pile installation duration and observations
9. Total length of installed helical pile
10. Cut-off elevation.
11. Inclination
12. Installation torque at one-foot intervals for the entire length.
13. Comments pertaining to interruptions, observations, rate of advancement or other relevant information.

1.8 QUALITY ASSURANCE

A. Qualifications of the Helical Pile Contractor: The helical pile Contractor shall be experienced in the installation of helical pile foundations and shall furnish all materials, labor, and supervision to perform the work. The Contractor shall provide names of on-site personnel materially involved with the work, including those who carry documented certification of helical pile training. At a minimum, these personnel shall include foreman, machine operator, and project engineer/manager.
   1. The helical pile Contractor shall not sublet the whole or any part of the contract without the express written permission of the Owner.

B. The Contractor shall employ an adequate number of skilled workers who are experienced in the necessary crafts and who are familiar with the specified requirements and methods needed for proper performance of the work of this specification.

C. All helical piles shall be installed in the presence of a designated representative of the Owner unless said representative informs the Contractor otherwise. The designated representative shall have the right to access any and all field installation records and test reports.

D. Helical pile components as specified therein shall be manufactured by a facility whose quality systems comply with ISO (International Organization of Standards) 9001 requirements. Certificates of Registration denoting ISO Standards Number shall be presented upon request to the Owner or their representative.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile excavation.

A. Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

   1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.

   2. The geotechnical report is included elsewhere in the Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for helical piers. Record actual measurements of each pile's location, bottom and top elevations, deviations from specified tolerances, and other specified data.

   1. Record and maintain information pertinent to each pier and indicate on record Drawings. Cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, to design piers, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Design Loads: As indicated on Drawings.

2.2 CENTRAL STEEL SHAFT

A. The central steel shaft, consisting of lead sections, helical extensions, and plain extensions, shall be as required by delegated design and as manufactured by A.B.Chance or approved equal.

B. Single Bar Solid Square Shaft Material (1.5”x1.5”): Shall be hot rolled Round-Cornered-Square (RCS) solid steel bars meeting dimensional and workmanship requirements of ASTM A29. The bar shall be modified medium carbon steel grade (similar to AISI 1044) with improved strength due to fine grain size.
1. Torsional strength rating = 5,500 ft-lb
2. Minimum yield strength = 70 ksi

C. Solid Square Shaft Material (1.75”x1.75”): Shall be hot rolled Round-Cornered-Square (RCS) solid steel bars meeting the dimensional and workmanship requirements of ASTM A29. The bar shall be High Strength Low Alloy (HSLA), low to medium carbon steel grade with improved strength due to fine grain size.
1. Torsional strength rating: = 11,000 ft-lb

2. Minimum yield strength = 90 ksi

D. Solid Square Shaft Material (2.0”x2.0”): Shall be hot rolled Round-Cornered-Square (RCS) solid steel bars meeting the dimensional and workmanship requirements of ASTM A29. The bar shall be High Strength Low Alloy (HSLA), low to medium carbon steel grade with improved strength due to fine grain size.
1. Torsional strength rating: = 16,000 ft-lb
2. Minimum yield strength = 90 ksi

E. Solid Square Shaft Material (2.25”x2.25”): Shall be hot rolled Round-Cornered-Square (RCS) solid steel bars meeting the dimensional and workmanship requirements of ASTM A29. The bar shall be High Strength Low Alloy (HSLA), low to medium carbon steel grade with improved strength due to fine grain size.
1. Torsional strength rating: = 23,000 ft-lb
2. Minimum yield strength = 90 ksi

F. Pipe Shaft Material (2.875” O.D.): Shall be structural steel tube or pipe, seamless or straight-seam welded, per ASTM A500 Grade B. Wall thickness is 0.203” (schedule 40)
1. Torsional strength rating = 5,500 ft-lb
2. Minimum yield strength = 50 ksi

G. Pipe Shaft Material (2.875” O.D.): Shall be structural steel tube or pipe, seamless or straight-seam welded, per ASTM A500 Grade B. Wall thickness is 0.276” (schedule 80).

1. Torsional strength rating = 8,000 ft-lb
2. Minimum yield strength = 50 ksi

H. Pipe Shaft Material (3.5" O.D.): Shall be structural steel tube or pipe, seamless or straight-seam welded, ASTM A53, A252, A500, or A618. Wall thickness is 0.300" (schedule 80).
1. Torsional strength rating = 13,000 ft-lb
2. Minimum yield strength = 50 ksi

2.3 HELIX BEARING PLATE:

A. Helix plates material shall be hot rolled carbon steel sheet, strip, or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate material shall conform to the following ASTM specifications.

B. Solid Square Shaft Material (Torque ≤ 5,500 ft-lb): Per ASTM A572, or A1018, or A656 with minimum yield strength of 50 ksi. Plate thickness is 3/8.

C. Solid Square Shaft Material (Torque ≥ 5,500 ft-lb): Hot rolled steel sheet, strip or plate per ASTM A656 or A936 with minimum yield strength of 80 ksi. Plate thickness is 3/8" or 1/2".

D. Pipe Shaft Material (Torque ≤ 5,500 ft-lb.): Hot Rolled carbon steel, strip, or plate per ASTM A568 with minimum yield strength of 50 ksi. Alternate materials are A-36 or ASTM A572 Grade 50. Plate thickness is 3/8".

E. 4.2.4 Pipe Shaft Material (Torque ≥ 5,500 ft-lb.): Per ASTM A36, or A572, or A1018, or A656 depending on helix diameter, with minimum yield strength of 80 ksi. Plate thickness is 3/8" or 1/2.

2.4 BOLTS

A. The size and type of bolts used to connect the central steel shaft sections together shall conform to the following ASTM specifications

B. Solid Square Shaft Material (Torque ≤ 7,000 ft-lb): 3/4" diameter bolt per ASTM A320 Grade L7.

C. Solid Square Shaft Material (Torque ≥ 7,000 ft-lb): 7/8" – 1-1/4" per ASTM A193 Grade B7

D. Pipe Shaft Material (Torque ≤ 13,000 ft-lb): ¾" diameter bolts (# of bolts per coupling depends on torque) per SAEJ429 Grade 5
1. SAE J429 Grade 5: Sy (min) = 92 ksi, Su (min) = 120 ksi

2.5 COUPLINGS

A. Couplings shall be capable of transmitting both the maximum installation torque from the tool string to the helix plates.

2.6 PLATES, SHAPES, OR PIER CAPS

A. Structural steel plates and shapes for helical pile top attachments shall conform to ASTM A36 or ASTM A572 Grade 50.

2.7 CORROSION PROTECTION

A. Galvanization: All helical pile material that is not encased in concrete shall be hot-dipped galvanized in accordance with ASTM A153 after fabrication.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, and other hazards created by drilling operations.

B. Rough grade ground elevation at pier locations.

3.2 SITE CONDITIONS

A. Prior to commencing helical pile installation, the Contractor shall inspect the work of all other trades and verify that all said work is completed to the point where helical pile installation may commence without restriction.

B. The Contractor shall verify that all helical piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.

C. In the event of a discrepancy, the Contractor shall notify the Owner. The Contractor shall not proceed with helical pile installation in areas of discrepancies until said discrepancies have been resolved.

3.3 ALLOWABLE TOLERANCES

A. Centerline of helical pile shall not be more than 3 inches from indicated plan location.

B. Helical pile plumbness shall be within 2□ of design alignment.

C. Top elevation of helical pile shall be within +1 inch to –2 inches of the design vertical elevation.

3.4 INSTALLATION EQUIPMENT

A. Shall be rotary type, hydraulic power-driven torque motor with clockwise and counter-clockwise rotation capabilities. The torque motor shall be capable of continuous adjustment to revolutions per minute (RPM's) during installation. Percussion drilling equipment shall not be permitted. The torque motor shall have torque capacity 15% greater than the torsional strength rating of the central steel shaft to be installed.

B. Equipment shall be capable of applying adequate down pressure (crowd) and torque simultaneously to suit project soil conditions and load requirements. The equipment shall be capable of continuous position adjustment and swing capacity at maximum installation torque to maintain proper helical pile alignment during installation. The application of bending stress to the pile during installation will not be permitted.

3.5 INSTALLATION TOOLING

A. Shall consist of a Kelly Bar Adapter (KBA) and drive tool as appropriate for the central shaft of the helical pile under maximum installation torque and used in accordance with the manufacturers written installation instructions.

B. Installation tooling should be maintained in good working order and safe to operate at all times. Flange bolts and nuts should be regularly inspected for proper tightening torque. Bolts, connecting pins, and retainers should be periodically inspected for wear and/or damage and replaced with identical items provided by the manufacturer. Heed all warning labels. Worn or damaged tooling should be replaced.

C. A torque indicator shall be used during helical pile installation. The torque indicator shall be a device that directly measures torque and that is mounted in-line with the installation tooling. Devices that infer torque from hydraulic pressure will not be permitted.
   1. Shall be capable of providing continuous measurement of applied torque throughout the installation.
   2. Shall be capable of torque measurements in increments of 200 ft-lb or less.
   3. Shall be re-calibrated, if in the opinion of the Owner and/or Contractor reasonable doubt exists as to the accuracy of the torque measurements.

3.6 INSTALLATION PROCEDURES

A. The helical pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project.

B. The lead section shall be positioned at the location as shown on the working drawings. Battered helical piles can be positioned perpendicular to the ground to assist in initial advancement into the soil before the required batter angle shall be established. The helical pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of not to exceed 16 RPM’s. The extension sections shall be provided to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt(s) and nut torqued to 40 ft-lb.
   1. Sufficient down pressure shall be applied to uniformly advance the helical pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

3.7 TERMINATION CRITERIA

A. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.

B. The minimum installation torque and minimum overall length criteria as shown on the technical submittal shall be satisfied prior to terminating the helical pile foundation installation.

C. If the torsional strength rating of the central steel shaft and has been reached prior to achieving the minimum overall length required, the Contractor shall have the following options:
   1. Terminate the installation at the depth obtained subject to the review and acceptance of the Owner, or:
   2. Remove the existing helical pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner.

D. If the minimum installation torque as shown on the working drawings is not achieved at the minimum overall length, and there is no maximum length constraint, the Contractor shall have the following options:
   1. Install the helical pile deeper using additional extension sections, or:
   2. Remove the existing helical pile and install a new one with additional and/or larger diameter helix plates.
   3. De-rate the load capacity of the helical pile and install additional helical screw foundation(s). The de-rated capacity and additional helical screw foundation location shall be subject to the review and acceptance of the Owner.

E. If the helical pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the pile removed. The obstruction shall be removed, if feasible, and the helical pile re-installed. If the obstruction can't be removed, the helical pile shall be installed at an adjacent location, subject to review and acceptance of the Owner.

F. If the torsional strength rating of the central steel shaft and has been reached prior to proper positioning of the last plain extension section relative to the final elevation, the Contractor may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension, the Contractor may cut said extension shaft to the correct elevation. The Contractor shall not reverse (back-out) the helical pile to facilitate extension removal.

G. The average torque for the last three feet of penetration shall be used as the basis of comparison with the minimum installation torque as shown on the working drawings. The average torque shall be defined as the average of the last three readings recorded at one-foot intervals.

3.8 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections: Pile installation.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 316615

COLUMBIA COUNTY
BOARD OF COMMISSIONERS

COLUMBIA COUNTY

ENGINEERING DIVISION

CONSTRUCTION STANDARD

SPECIFICATIONS

AND DETAILS

Columbia County
Engineering Services Division
Road Construction Department
(706) 447-7600

Revised: December 2023

PREFACE

COLUMBIA COUNTY ENGINEERING DIVISION
CONSTRUCTION STANDARDS AND SPECIFICATIONS:

ALL DESIGN AND CONSTRUCTION WITHIN RIGHTS-OF-WAY AND/OR EASEMENTS OWNED BY COLUMBIA COUNTY, OR TO BE DEDICATED TO COLUMBIA COUNTY AT ANY POINT IN THE FUTURE, SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE FOLLOWING STANDARDS AND SPECIFICATIONS, UNLESS OTHERWISE APPROVED BY THE COUNTY ENGINEER.

ROADWAY INFRASTRUCTURE CONSTRUCTION:

- Subdivision Roads – Construction standards and specifications shall be in accordance with ***Columbia County Engineering Division Construction Standard Specifications and Details***. Construction standards and specifications not addressed herein shall be in accordance with respective GDOT/AASHTO/MUTCD guidelines.
- Non-Subdivision Roads – Construction standards and specifications shall be in accordance with respective GDOT/AASHTO/MUTCD guidelines.

WATER UTILITY INFRASTRUCTURE CONSTRUCTION:

- Construction standards and specifications shall be in accordance with the ***Columbia County Water Utility Construction Standards and Specifications***.

SUPPLEMENTAL DESIGN AND CONSTRUCTION RESOURCES:

- **Columbia County Board of Commissioners (CCBOC)**
  - *CCBOC Code of Ordinances*
  - *CCBOC Design Supplement A Pavement System Design Requirements*
  - *CCBOC Driveway Encroachment Policy Manual*
  - *CCBOC Projects Access Improvements Manual*
  - *CCBOC Stormwater Supplement*
  - *CCBOC Utility Accommodation Standards, Policies and Procedures Manual*
  - *CCBOC Work Zone Traffic Control Procedure*
- **Georgia Department of Transportation (GDOT)**
  - *GDOT Construction Standards and Details*
  - *GDOT Regulations for Driveway and Encroachment Control*
  - *GDOT Standard Specifications Construction of Transportation Systems*
- **American Association of State Highway and Transportation Officials (AASHTO)**
  - *AASHTO A Policy on Geometric Design of Highways and Streets*
  - *AASHTO Roadside Design Guide*
  - *AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities*
- **American Society for Testing and Materials (ASTM)**
- **Institute of Transportation Engineers (ITE)**
- **Manual on Uniform Traffic Control Devices (MUTCD)**

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Stormwater Details

Traffic Details

SPECIFICATIONS

COLUMBIA COUNTY
GEORGIA

1.0 GENERAL

1.1 Applicability

1.1.1 Construction of Public Works by Private Parties under Contract with Columbia County

It is the intention of these specifications that all work done by the contractor under contract with Columbia County, as owner, be done in strict accordance with the Project Documents.

1.1.2 Construction of Public Works by Private Parties to be Dedicated to Columbia County

It is the intention of these specifications that all work done by the contractor for private parties, which is intended to be dedicated to Columbia County, either immediately or at any time in the future, shall be done in strict accordance with the Project Documents.

1.2 Responsibility

1.2.1 General

The presence or absence of the County Engineer on the site does not relieve the Contractor from performing all work in strict accordance with the Project Documents.

1.2.2 Permits, Fees, and Legal Requirements

The Contractor is responsible for obtaining all permits, paying all fees, and complying with all local, state, and federal regulations.

1.3 Control of Work

The term "County Engineer" as used in these specifications refers to the County Engineer of Columbia County, Georgia. County Staff Project Engineers/Inspectors assigned to the work by the County Engineer are authorized to perform such duties as deemed necessary in representing the County Engineer.

All work on the project shall be performed in an orderly and logical sequence to produce the highest quality product. If, in the opinion of the County Engineer, the work is performed in an unsatisfactory sequence that may cause long term detrimental consequences to the project, the County Engineer has the authority to direct the work sequence be performed in the most satisfactory way.

The County Engineer has the authority to suspend the work, in whole or in part, and to revoke the Land Disturbance Permit for the project for failure to carry out the provisions of the Project Documents, for failure to perform work in reasonably close conformance with the Project Documents, for failure to correct unsafe conditions for

workers or the general public, and for any reason or condition that is in the best interest of the County.

1.4 Project Documents Precedence

All Project Documents including the Special Provisions, Plans, Supplemental Specifications, Standard Drawings, Standard Specifications, and any supplemental documents that are part of the Contract shall be followed in strict accordance. If any discrepancy should arise, the order of precedence is as follows:

1) Special Provisions
2) Plans
3) Supplemental Specifications
4) Standard Drawings
5) Standard Specifications

1.5 Ambiguities

In the case of ambiguous Project Documents or typographical errors, the County Engineer shall provide the interpretations or application of the specification in question.

1.6 Waivers

The County Engineer may waiver in writing whatever sections of the Project Documents as are appropriate to meet existing field conditions.

1.7 References

Mention of any referenced Project Document or other publication refers to the current edition of that document or its replacement.

1.8 Damages

Any existing materials, property, structure or other item damaged by the Contractor shall be repaired to the satisfaction of the County Engineer and in accordance with the applicable section of the Project Documents. The cost for all such repairs shall be paid for by the Contractor.

1.9 Material Testing

Unless specified otherwise, the Contractor shall perform Quality Control (QC) material testing. QC material testing shall be performed at the Contractor's expense. Any work that fails to meet the requirements of the Project Documents shall be retested at the Contractor's expense. All QC test reports shall be submitted to the County Engineer on a weekly basis for approval; in no case shall the time frame between submission of reports exceed 7 calendar days.

Columbia County reserves the right to perform Quality Assurance (QA) material testing at its own expense when deemed necessary by the County Engineer.

1.10 Notification

For all phases of work requiring approval, the Contractor must notify the County Engineer at least two working days before the inspection is necessary.

2.0 CLEARING AND GRUBBING

2.1 General

2.1.1 Description

The work covered by this section of the specifications consists of furnishing all labor, equipment, materials, and appurtenances in performing the removal and disposal of all trees, brush, stumps, logs, grass, weeds, roots, decayed vegetable matter, rock debris, posts, fences, stubs, rubbish, and all other objectionable matter resting on or protruding through the original ground surface and occurring within the construction limits, easement or right of way. The work shall be performed in strict accordance with Project Documents.

2.1.2 Preservation

This work shall also include the preservation from injury or defacement of all vegetation and objects outside the limits of clearing as shown on the plans or designated to remain.

2.1.3 Erosion Control

The Erosion and Sedimentation Control plan shall be approved and implemented prior to clearing and grubbing operations.

2.1.4 Permits

The Contractor shall obtain all necessary permits, licenses and other authorization from the appropriate authorities before any construction may begin.

2.2 Construction

2.2.1 Clearing

2.2.1.1 Clearing shall consist of the felling, cutting or trimming of trees, vegetation and other objectionable material and the satisfactory disposal of cleared material from the site as indicated on the drawings or as directed by the County Engineer together with the down timber, snags, brush, and rubbish occurring within the areas to be cleared.

2.2.1.2 Clearing also includes the removal and proper disposal of all obstructions not to be retained, such as fences, bridges, buildings, and other incidental material aforementioned.

2.2.1.3 Clearing operations shall be conducted so as to prevent damage to trees left standing, to existing structures and installations, and to any items designated to remain in place.

2.2.2 Grubbing

2.2.2.1 Grubbing shall consist of the removal from the construction limits, easement or right-of-way and proper disposal of all objectionable material which is embedded in the underlying soil.

2.2.2.2 Within the grading limits, stumps, roots, logs, or other timber, matted roots and other objectionable material shall be removed to a minimum depth of 18 inches or as directed by the County Engineer.

2.2.2.3 All depressions excavated below the original ground surface for or by the removal of stumps and roots, shall be refilled with suitable clean material as indicated on the plans or as directed by the County Engineer and compacted to make the surface conform to the surrounding ground surface.

2.3 Disposal of Materials

2.3.1 Compliance

The Contractor shall dispose of all waste materials at his expense and in accordance with all local, state, and federal regulations.

2.3.2 Salvageable Material

Saw logs, pulpwood, cord wood, or other merchantable timber removed in the above operations shall become the property of the Contractor and may be sold by him provided such disposal is otherwise in accordance with these specifications and is not noted otherwise in the Project Documents.

2.3.3 Non-Salvageable Material

All non-salvageable material shall be removed and disposed of at a location approved by the County Engineer.

3.0 ROADWAY EXCAVATION AND EMBANKMENT

3.1 General

3.1.1 Description

Roadway excavation and embankment shall consist of the excavation, hauling and satisfactory placement or disposal of all materials from within the limits of construction, easement or right-of-way including designated borrow areas, in strict accordance with the Project Documents.

3.1.2 Conformity

All work shall be in conformity with the Project Documents or as directed by the County Engineer.

3.2 Excavation

3.2.1 Unclassified Excavation

3.2.1.1 The term excavation used hereinafter is defined as "unclassified excavation." Excavation of every description regardless of material encountered within the grading limits of the project, shall be performed in strict accordance with the Project Documents.

3.2.1.2 Rock is considered unclassified excavation and shall be excavated to a depth of 18-inch minimum below the subgrade.

3.2.2 Unsuitable Material

All unsuitable material encountered within the limits of the work shall be excavated below the grade shown and backfilled with suitable material, properly compacted in accordance with Section 3.3.1.2. Such suitable material shall conform to Georgia Department of Transportation Specification 812. Backfill materials, Type I or Type II, shall be devoid of weeds, underbrush, roots, wood, trash of all description, and other foreign materials.

3.3 Embankment

3.3.1 Compaction

3.3.1.1 Embankment shall be placed in uniform, horizontal layers no greater than 8 inches loose, and shall be compacted by mechanical means.

3.3.1.2 Each layer of embankment shall be uniformly compacted to at least 95% of maximum dry density to within 12 inches of the top of the embankment. The top 12 inches shall be compacted to 100% maximum dry density. Compaction shall be based upon the standard proctor method per ASTM D698, or as directed by the County Engineer.

3.4 Cement Stabilized Sub-Grade

3.4.1 Description

This work consists of construction of one or more courses of a mixture of soil, cement, and water as indicated in the Project Documents, and in conformity with the lines, grades, thickness, and typical cross sections shown on the plans for the purpose of stabilizing existing soil properties.

3.4.2 Materials

3.4.2.1 Cement shall be Type I or Type I/II meeting the requirements of ASTM C 150. The source of the cement shall recognized by GDOT QPL and approved in advance of stabilization operations in order that Standard Proctor tests can be completed. The source of cement shall be submitted to the County Engineer for approval, prior to use. Cement shall be stored and handled in closed weatherproof containers until immediately before distribution. Cement exposed to moisture prior to mixing with soils shall be discarded.

3.4.2.2 Water used for mixing or curing shall be reasonably clean and free of oil, salt acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

3.4.2.3 Soil for this work consists of materials on the site or selected materials from other sources and shall be uniform in quality and gradation, and shall be approved by the County Engineer. The soil shall be free of roots, sod, weeds, and stones larger than 1 ½ inches.

3.4.3 Composition

The amount of cement to use, and the application procedure depends on the soil classification and should be established to achieve a 300 psi unconfined compressive strength in a sample test. The amount and procedure should not produce an unconfined compressive strength of greater than 450 psi to avoid the sub-base behaving as a rigid pavement, as this may negatively affect the performance of the asphalt pavement layers. The percent of cement and application procedure should be determined through appropriate laboratory testing and shall be based on a minimum mixing depth of 8 inches.

3.4.4 Roadway Pavement Design Method Submittal

The Mix Design shall be submitted to the County Engineer for approval, prior to use, as outlined in Columbia County Design Supplement A.

3.4.5 Tolerances

At final compaction, the cement and water content for each course of subgrade treatment shall conform to the following tolerances
Material Tolerance
Cement +0.5%, -0%
Water +2.0%, -0%

3.4.6 Construction

3.4.6.1 The cement treated subgrade shall not be mixed while the atmospheric temperature is below 35°F or when conditions indicate that temperatures may fall below 35°F within 24 hours, when it is foggy, rainy, or when soil or subgrade is frozen.

3.4.6.2 The equipment required shall include all equipment necessary to complete this item such as: grading and scarifying equipment, a spreader for the cement, mixing or pulverizing equipment, sheepsfoot, and pneumatic rollers, water delivery equipment, and trucks.

3.4.6.3 It is the primary requirement of this specification to secure a completed stabilized subgrade containing a uniform cement mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses. The Contractor shall regulate the sequence of work, to apply specified rates of cement, maintain the work, and rework the courses as necessary to meet the above requirements.

3.4.6.4 The area to be incorporated with cement shall be graded from at grade to 0.10 feet below final grading lines before incorporation will be allowed. The Contractor shall provide the County Engineer facilities with which to check proper grading in anticipation of cement incorporation. Pre-application grading shall be based upon the proposed rate and the intent to provide the final 8 inch layer of cement-treated subgrade in conformity with the lines and grades specified in the plans.

3.4.7 Cement Application

3.4.7.1 Cement shall be spread only on areas where the mixing and compaction operations can be completed within 2 hours. The amount of cement spread shall be the amount required to obtain the cement content as determined from the mix design.

3.4.7.2 The cement shall be spread uniformly over the top of the subgrade by an approved screw-type spreader box or other approved spreading equipment. The cement shall be distributed in such a manner that scattering by wind will be minimal. Cement shall not be applied when wind or other weather conditions, in the opinion of the County Engineer, are detrimental to a proper application.

3.4.7.3 The full depth of the treated subgrade shall be mixed with the pulverizing mixer. Cement shall not be left exposed for more than 30 minutes after application. The pulverizing mixer shall make a minimum of two passes to incorporate the cement into the soil. Water shall be added through use of a pulverizing mixer equipped with a spray bar in the mixing drum capable of applying sufficient quantities of water to achieve the required moisture content of the soil-cement mixture. The system shall be capable of being regulated to the degree as to maintain moisture contents within the specified range.

3.4.7.4 Specified moisture contents shall be established by the Design Engineer based on Standard Proctor tests with the site soils and the specific cement to be used for the treatment. Final moisture content of the mix, immediately prior to compaction, shall not be below nor more than 2% above the optimum moisture content for maximum density of the mix. If moisture contents exceed the specified limits, additional cement may be added to lower the moisture content to the required limits. Lowering moisture contents by aeration following addition of the cement will not be permitted.

3.4.8 Testing

3.4.8.1 All camera inspections and subsequent repairs shall be complete prior to installation of cement stabilized subgrade and curb on all projects.

3.4.8.2 All testing specified below shall be performed by the Contractor, unless otherwise noted. Submission of all test reports to the County Engineer shall be in accordance with Section 1.9 of these Specifications.

3.4.8.3 Spread rates shall be checked a minimum of once daily or more often as determined by County Engineer.

3.4.8.4 Compaction of the soil-cement mixture shall begin immediately after mixing of the cement and be completed within 2 hours following incorporation of the cement. The field density of the compacted mixture shall

be at least 100% of the maximum density (Standard Proctor) of laboratory specimens prepared from samples taken from the material in place

3.4.8.5 The Contractor shall perform QC compaction testing of the embankment at the following minimum frequency: 1 test every 500 linear feet. Additional QC testing may be performed as needed to ensure compaction requirements are being met. The County Engineer may perform QA testing of the material as needed.

3.4.8.6 Irregularities, depressions, or weak spots, which develop, shall be corrected immediately by scarifying the area affected, adding or removing material as required, and reshaping and re-compacting. The surface of the course shall be maintained in a smooth condition, free from undulations, and ruts, until other work is placed thereon or the work is accepted.

3.4.8.7 Compaction tests shall be performed after each section is completed. If the material fails to meet the density requirements, it shall be reworked to meet these requirements. Throughout this operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the plans and to the established lines and grades. Should the material lose the required stability, density, and finish before the next course is placed or the work is accepted; it shall be re-compacted and refinished.

3.4.8.8 The thickness of the cement treated subgrade shall be determined by depth checks or cores taken at intervals so that each test will represent no more than 500 linear feet or as approved by the County Engineer. When the base thickness is deficient by more than ½ inch, the Contractor shall correct such areas in a manner satisfactory to the County Engineer. The Contractor shall replace the base material where borings are taken for test purposes. The County Engineer may perform additional testing as needed.

3.4.9 Finishing and Curing

3.4.9.1 After the final layer or course of the cement treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surfaces shall not vary more than 1/2 inch when tested with a 10 foot straightedge applied parallel with and at right angles to the subgrade centerline. Any variations in excess of this tolerance shall be corrected by the Contractor in a manner satisfactory to the County Engineer.

3.4.9.2 After the cement treated course has been finished as specified herein, the surface shall be protected against rapid drying and maintained in a thorough and continuously moist condition until the pavement section is placed.

3.4.10 Maintenance

The Contractor shall maintain the cement treated subgrade in good condition from the start of work until all the work has been completed, cured, and accepted by the County Engineer. Traffic permitted on uncovered stabilized subgrade shall be limited to equipment to satisfy the work. Excessive traffic shall be avoided until full curing of the subgrade has occurred.

3.5 QC/QA Testing

The Contractor shall perform QC testing of the embankment at the following minimum frequency: 1 test per lift of embankment per every 500'. Additional QC testing may be performed as needed to ensure compaction requirements are being met. All QC testing shall be submitted in accordance with Section 1.9 of these Specifications.

The County Engineer may perform QA testing of the embankment as needed.

3.6 Final Finishing of Roadbed

3.6.1 Roadway Surface

After completion of roadway excavation and embankment, the entire surface of the roadbed and slopes shall be shaped to true grade, alignment, and cross-section as shown in the Project Documents

3.6.2 Drainage

During construction, all excavation, embankment, ditches, drains, and culverts within the construction limits, easements, or right of way shall be constructed in a manner and sequence as to provide suitable drainage at all times.

4.0 CONSTRUCTION OF SUB-BASE

4.1 General

4.1.1 Description

This work shall consist of placing, mixing, compacting, and shaping the top 8 inches of the roadbed in both excavation and embankment areas.

4.2 Construction

4.2.1 Sub-Base Construction

The entire surface of the in place sub-base shall be thoroughly mixed to a depth of 8 inches. After the material has been thoroughly mixed, the sub-base shall be brought to line and grade and compacted to 100% of the maximum dry density. Compaction shall be based upon the standard proctor method per ASTM D698, or as directed by the County Engineer.

The limits of the sub-base shall underlay the proposed base course plus three (3) feet on each side.

4.2.2 Finishing Sub-Base

4.2.2.1 The surface of the completed sub-base shall be bladed to a smooth and uniform texture. The design centerline profile and template cross-section shall conform to the established elevations within an acceptable tolerance of ± ½ inch.

4.2.2.2 The area between the top of curb and right-of-way shall be finish graded to a uniformly smooth surface free from any abrupt irregularities and in close conformance with Plans.

4.2.2.3 Prior to the placement of base material, the Contractor shall provide all test results for the sub-base, as noted in the Project Documents, to the County Engineer for approval. All testing of the sub-base will be performed at the Contractor's expense.

4.2.2.4 The sub-base shall conform to current Georgia Department of Transportation Specification, Section 810 for Class IA material; however, at no time shall any sub-base clay content exceed 16%. Should the material not meet Georgia Department of Transportation Specification, Section 810 for Class IA material, the Design Engineer shall submit his/her method of stabilizing to the County Engineer for approval.

4.2.3 Roadway-Pavement Design Method Submittal

The Design Engineer shall submit a roadway design in conformance with Design Supplement A, Pavement System Design Requirements for Columbia County to the County Engineer for approval.

4.3 Proof Rolling

4.3.1 Extent

Proof rolling shall be done on all portions of the sub-base or sub-grade underlying the base, which includes three (3) feet of width on each side of the base. The surface shall be in a finished condition ready for the placement of base material.

4.3.2 Means

4.3.2.1 All sub-base and sub-grade shall be compacted and shaped to a firm and non-yielding surface prior to placement of another layer or course.

4.3.2.2 Proof roll shall be performed with a tandem axle dump truck loaded to a minimum gross load of 56,000 pounds provided by the Contractor with no exceptions.

4.3.2.3 The pattern for the proof roll shall be up, back and then the test roll.

4.3.2.4 All proof rolling shall be done in the presence of the County Engineer

4.3.3 Repairs to Sub-Base and Sub-Grade

4.3.3.1 All deficient areas shall be satisfactorily repaired and retested.

4.3.3.2 In the event of a rain event exceeding 0.25 inches, after a passing proof roll, the area shall be subject to retesting.

4.4 Protection of Existing Service Lines and Utilities

The Contractor shall be responsible for the location and protection of all services and utilities of any description and for notifying and coordinating with the appropriate utility companies of work to be performed within the limits of the right-of-way, easements, or construction limits. This shall include all lines and/or structures.

4.5 Restoration of Property

The Contractor shall carefully restore all property defaced or damaged by operations or acts of any of his agents, employees, or subcontractors. Such restoration shall include seeding, sodding, and transplanting of lawns, hedges, ornamental plantings and repair

or replacement of driveways, walks, fences, steps or other facilities and shall be in like quality to the original undisturbed work.

4.6 Reconstruction or Adjustment to Grade of Miscellaneous Structures

The Contractor shall reconstruct or adjust to grade all manholes, water valve boxes, catch basins, traps, or the like within the right-of-way, easements, or construction limits.

4.7 QC/QA Testing

The Contractor shall perform QC testing of the sub-base at the following minimum frequency: 1 test every 500'. Additional QC testing may be performed as needed to ensure compaction requirements are being met. All QC testing shall be submitted in accordance with Section 1.9 of these Specifications.

The County Engineer may perform QA testing of the sub-base as needed.

5.0 CONSTRUCTION OF BASE COURSE

5.1 Definition

This work shall consist of, but not be limited to, the premixing, hauling, placing, compaction, and shaping of the base course.

5.2 Material

5.2.1 Graded Aggregate Base

Before any graded aggregate base material is brought on site, the Design Engineer shall submit a roadway design in conformance with Design Supplement A, Pavement System Design Requirements for Columbia County to the County Engineer for approval.

5.2.2 Additional Graded Aggregate Base

At the discretion of the County Engineer additional thickness of graded aggregate base material may be required.

5.3 Construction

5.3.1 Preparation of Sub-Base

The construction of the graded aggregate base course shall not commence until the sub-base has been construction in accordance with Section 4.2 and to the satisfaction of the County Engineer.

5.3.2 Placement

Graded aggregate base shall be placed in a manner as to prevent segregation and in accordance with Section 310.3.05.A.2 of the Georgia Department of Transportation Specifications.

5.3.3 Compaction

After the graded aggregate base material has been placed and brought to line, grade, and cross-section, it shall be compacted to 100% maximum dry density. Compaction shall be based upon standard proctor method per AASHTO T 310.

5.3.4 QC/QA Testing

The Contractor shall perform QC testing of the base at the following minimum frequency: 1 test every 500 feet. Additional QC testing may be performed as needed to ensure compaction requirements are being met. All QC testing shall be submitted in accordance with Section 1.9 of these Specifications.

The County Engineer may perform QA testing of the base as needed.

5.4 Finish Grading

5.4.1 Roadway Surface

5.4.1.1 The Contractor shall finish off the surface to a smooth and uniform surface, free from abrupt changes and sloping to the edges at a rate of ¼ inch per foot. The surface may vary from profile and cross section at any given point by no more than ¼ inch.

5.4.1.2 The final surface shall be constructed in strict accordance with the Plans.

5.4.2 Finished Shoulders

The Contractor shall ensure the areas from the edge of the road or back of curb to the right-of-way and utility easements are finished to a uniformly smooth surface, free from abrupt surface changes.

5.5 Proof Rolling

5.5.1 Extent

Proof rolling shall be done on all portions of the graded aggregate base. The surface shall be in a finished condition ready for the placement of asphaltic material.

5.5.2 Means

5.5.2.1 The graded aggregate base shall be compacted and shaped to a firm and non-yielding surface prior to placement of another layer or course.

5.5.2.2 Proof roll shall be performed with a tandem axle dump truck loaded to a minimum gross load of 56,000 pounds provided by the Contractor with no exceptions.

5.5.2.3 The pattern for the proof roll shall be up, back and then the test roll.

5.5.2.4 All proof rolling shall be done in the presence of the County Engineer

5.5.3 Repairs to Graded Aggregate Base

5.5.3.1 All deficient areas shall be satisfactorily repaired and retested.

5.5.3.2 In the event of a rain event exceeding 0.25 inches, after a passing proof roll, the area shall be subject to retesting.

5.6 Protection of Surface.

5.6.1 Graded Areas

5.6.1.1 The Contractor shall be responsible for the protection of all graded areas including the roadway, shoulders, ditches, swales, etc. within the right-of-way, easement, or limits of construction.

5.6.1.2 The graded areas shall be protected from traffic and erosion or damage in any form or manner. Any settlement, washing, silting, sanding, or damage that may occur from any cause shall be repaired and grades re-established according to the required grades or elevations.

5.6.2 Roadway

Unless otherwise specifically noted, the Contractor shall maintain the roadway until application of the surface course and during the warranty period.

5.7 Protection of Existing Service Lines and Utilities

Protection of existing service lines and utilities shall be performed in accordance with Section 4.4 of these Specifications.

5.8 Restoration of Property

Restoration of property shall be performed in accordance with Section 4.5 of these Specifications.

5.9 Reconstruction or Adjustment to Grade of Miscellaneous Structures

Reconstruction or adjustment to grade of miscellaneous structures shall be performed in accordance with Section 4.6 of these Specifications.

6.0 BITUMINOUS PRIME COAT AND/OR TACK COAT

6.1 Prime Coat Description

This work shall consist of preparing and treating a prepared base course or an existing surface with bituminous material and blotter material, if required, in accordance with these specifications. All base courses shall be primed with the exception of sand asphalt or asphaltic concrete base material. Prime shall not be applied until all conditions of Section 5.0 have been met and the base course approved by the County Engineer.

6.2 Tack Coat Description

This work shall consist of preparing and treating an existing surface with bituminous material in accordance with these specifications.

6.3 Material for Prime Coat and/or Tack Coat

Unless otherwise specified, all materials used shall meet the requirements of Georgia Department of Transportation Quality Products List (QPL) for prime coat and/or tack coat.

6.4 Prime Coat Construction

6.4.1 Weather

6.4.1.1 Prime coat shall not be applied on a wet surface nor when the ambient air temperature is below 40 degrees F in the shade. Prime coat shall not be applied when weather conditions would prevent proper bonding and curing of the prime coat.

6.4.2 Condition of Surface

6.4.2.1 The surface to which the prime coat is to be applied shall have been finished to the line, grade, and cross section specified.

6.4.2.2 The surface shall be uniformly compacted and bonded. All irregularities occurring in the surface shall be corrected in accordance with the Project Documents for the particular construction being primed.

6.4.2.3 All loose material, dust, caked clay, and all other material likely to prevent penetration or bonding of the prime with the surface shall be removed from the road.

6.4.3 Heating and Applying Prime Coat

The prime coat shall be applied to the full width of paving plus six inches in areas without curb and gutter and in accordance with Section 412 of the Georgia Department of Transportation Specifications. Caution shall be exercised to avoid the placement of prime coat on concrete curb and gutters.

6.5 Tack Coat Construction

6.5.1 Weather

The tack coat shall not be applied on a wet surface nor when the ambient air temperature is below 40 degrees Fahrenheit in the shade. The tack coat shall not be applied when weather conditions would prevent proper bonding and curing of the tack coat.

6.5.2 Condition of Surface

The surface to which the tack coat is to be applied shall be clean and free from any material which would prevent the proper bonding and curing of the tack coat.

6.5.3 Applying Tack Coat

A tack coat of 0.02 gallons per square yard to 0.04 gallons per square yard shall be applied to new surfaces. A tack coat of 0.04 gallons per square yard to 0.08 gallons per square yard shall be applied to existing surfaces. These tack rates may be adjusted at the discretion of the County Engineer. The temperature of the tack coat shall be in accordance with Section 413 of the Georgia Department of Transportation Specifications.

The tack coat shall be applied to the full width of paving in areas without curb and gutter. For areas with curb and gutter or other structures, the contact face shall be coated with a thin uniform coat just prior to placement of asphalt courses. Caution shall be exercised to avoid the placement of tack coat on concrete curb and gutter.

6.6 Protection, Curing, and Maintenance

6.6.1 Closing to Traffic

The primed surface shall be closed to all traffic and left undisturbed for so long as necessary for the prime to cure and until it does not pick up under traffic.

6.6.2 Sanding (Blotting)

6.6.2.1 If necessary, or as directed by the County Engineer, clean, dry, sharp sand shall be spread by hand or mechanically, over the surface, to prevent the prime coat from being picked up.

6.6.2.2 Sand shall only be spread on places that are tacky and shall be the least amount needed to prevent it from being picked up.

6.6.3 Maintenance

The Contractor shall maintain the prime coat and the surface of the course primed until it is covered by other construction.

7.0 ASPHALT COURSES

7.1 General

7.1.1 Description

7.1.1.1 This specification covers the general requirements that are applicable to all types of bituminous plant mixtures irrespective of gradation of aggregate, kind, and amount of bituminous material or pavement use.

7.1.1.2 This work shall consist of the placement of bituminous plant mix on the prepared foundation surface in the required compacted thicknesses and in strict conformance with the Project Documents

7.1.2 Conformity

Except where otherwise indicated herein below, all work and materials shall conform to the requirements of Section 400 of the Georgia Department of Transportation Specifications.

7.2 Material

7.2.1 Type of Material

The asphalt concrete mixture shall conform to Section 400 of the Georgia Department of Transportation Specifications for mix designs as specified in Design Supplement A, Pavement System Design Requirements for Columbia County.

7.3 Construction

7.3.1 Weather

The mixing and placing of asphalt concrete mixtures shall not be performed when the existing surface is wet or frozen. The minimum temperature at which the asphalt concrete mixtures can be placed shall be in accordance with Section 400 of the Georgia Department of Transportation Specifications.

7.3.2 Preparation of Existing Surface

7.3.2.1 If the surface has been rained on, the surface shall be proof rolled again in the presence of the County Engineer prior to any paving operations commencing to ascertain any damage to the primed surface or base course. Repairs will be made as specified by the County Engineer.

7.3.2.2 Before beginning paving operations, the existing surface shall be cleaned. The cleaning operations shall include the removal of dust, foreign matter such as pine straw, leaves, sand, or any other objectionable material.

7.3.2.3 Before beginning paving operations, all damaged or deficient areas which require patching or repair as directed by the County Engineer shall be corrected prior to any mix being placed. Areas to be patched shall be cut out and all loose material removed. At the discretion of the County Engineer, defects, which are not excessive in depth, width or length, may be removed ahead of the paving operation, filled from the paving operation and overlaid. If the extent of the defect is excessive, the defect shall be removed, filled with acceptable material, and compacted before overlaying.

7.3.2.4 The surface of existing abutting roadways shall be thoroughly cleaned of all objectionable material and the tack coat shall be applied at the appropriate rate on the adjacent area being overlaid.

7.3.3 Transportation and Delivery

7.3.3.1 All asphalt concrete mixtures shall be transported and delivered in accordance with Section 400 of the Georgia Department of Transportation Specifications.

7.3.3.2 The County Engineer shall be notified at least 48 hours prior to the placement of any asphalt concrete mixtures.

7.3.3.3 The County Engineer may reject any load of asphalt concrete mixture that does not meet these Specifications. Reasons for rejection may include but are not limited to: mix temperature out of tolerance, equipment failure, uncoated aggregate, segregation, deleterious material in mix, etc.

7.3.4 Placement Sequence

The asphalt mixture shall be placed in a manner so as to minimize the amount of construction traffic that will travel on the pavement (i.e, complete asphalt paving operations on side roads first, beginning at the end of each side road; complete asphalt paving operations on the main roads last, beginning at the end of the main roads), or as approved by the County Engineer.

7.3.5 Bituminous Pavers and Spreading

All requirements for bituminous pavers and spreading shall be in accordance with Section 400 of the Georgia Department of Transportation Specifications.

7.3.6 Rolling and Compaction Operations

7.3.6.1 All requirements for rolling and compaction operations shall be in accordance with Section 400 of the Georgia Department of Transportation Specifications.

7.3.6.2 The types of roller equipment shall include, at a minimum, a breakdown roller, pneumatic-tired roller, and a finish roller.

7.4 Access

7.4.1 Access

In all cases, the Contractor shall ensure free access to the driveway without scraping, bumping, or rubbing of a vehicle entering or leaving the driveway during all phases of construction and upon acceptance of the work.

7.5 Adjoining Roads

7.5.1 Damaged Roadway

The adjoining pavement to new construction shall have all deficient and damaged pavement removed by the Contractor as directed by the County Engineer. The surface shall be cleaned and tacked as specified in Section 7.3.2.4.

7.6 Protection of Paving

All sections of new pavement shall be protected from traffic until the traffic will not mar the surface or alter the surface texture.

7.7 Testing

7.7.1 QA/QC Testing

The asphalt concrete mixture shall be tested in accordance with Section 400 of the Georgia Department of Transportation Standard Specifications. Copies of all of the Contractor's QC test results, along with the Asphaltic Concrete Lot Worksheet, shall be submitted in a timely manner to the County Engineer for approval.

The County Engineer may elect to check the thickness of the asphalt concrete mixture by obtaining three (3) inch asphalt core samples for each street. An asphalt core sample would be taken for each six hundred and fifty (650) lane feet per travel lane or one per travel lane if the street length is less than six hundred fifty (650) feet.

The County Engineer reserves the right to perform any additional testing of the asphalt concrete mixture as needed.

7.7.2 Tolerances

If the County Engineer elects to check the thickness of the asphalt concrete mixture by obtaining asphalt core samples, the following shall apply:

If the overall thickness of the asphalt core sample is deficient more than one eighth (1/8) of an inch from plan thickness, additional asphalt core samples shall be obtained at fifty (50) feet intervals on each side of the original asphalt core sample until an asphalt core sample is obtained that is within

tolerance. Once the deficient areas are determined, the Developer/ Design Engineer shall submit a Corrective Action Plan to the County Engineer for approval. Once corrective actions have been completed, additional asphalt sample cores shall be obtained to verify that the asphalt thickness in these areas is within tolerance.

Once all corrective actions have been completed, all asphalt core sample thicknesses shall be averaged to obtain an overall average pavement thickness for each street. If the overall average pavement thickness is deficient more than one eight (1/8) of an inch from plan thickness, the Developer/Design Engineer shall submit a Corrective Action Plan to the County Engineer for approval.

The County Engineer shall appoint an independent AASHTO accredited testing laboratory to obtain and analyze the asphalt core sample and to determine the final pavement thickness.

7.7.3 Penalty

All asphalt concrete mixtures shall be accepted, accepted with conditions, or rejected based on the Indicated Pay Factors as reported on the Asphaltic Concrete Lot Worksheet, as shown below.

Sieve Analysis
PF = 0.90 - 1.00 : Accepted without exceptions
PF = 0.80 - 0.85 : Accepted with an additional 1 year warranty
PF = Less than 0.80 : Remove and Replace

Asphalt Cement & Percent Air Voids
PF = 0.90 - 1.00 : Accepted without exceptions
PF = 0.50 - 0.80 : Accepted with an additional 1 year warranty
PF = Less than 0.50 : Remove and Replace

All additional warranties shall be in addition to the warranty stated in the Project Documents and shall apply only to the lot of asphalt mixture in question.

7.8 Smoothness

The finish surface shall not vary more than 1/4 inch in 10 feet from the true profile and cross-section.

7.9 Shoulders and Right-of-Way

7.9.1 Grading

In areas disturbed by the Contractor's operations, these areas shall be finish graded in accordance with Section 4.2.2.2.

7.9.2 Finishing

All trash, debris, construction material and equipment, excess dirt or asphalt, and all objectionable or unsightly material shall be removed by the Contractor from the right-of-way, easement, or limits of construction.

7.10 Restoration of Property

Restoration of property shall be performed in accordance with Section 4.5 of these Specifications.

8.0 CONCRETE CONSTRUCTION

8.1 General

This section covers concrete construction including reinforcing steel.

All concrete shall be sourced from a Georgia Department of Transportation approved concrete plant. All concrete mix designs shall be Georgia Department of Transportation approved and submitted to the County Engineer for approval.

All concrete with a 28 day minimum compressive strength of 4000 psi and greater shall be considered structural concrete. All concrete with a 28 day minimum compressive strength of 3000 psi and less shall be considered miscellaneous concrete.

8.2 Forms

8.2.1 Design

8.2.1.1 Forms, including their bracing and supports, shall be of sufficient strength to support the wet concrete and other loads and forces incidental to construction operations, without bulging between supports or bracing and without other deviation from the lines and contours shown on the plans.

8.2.1.2 When form work is, or appears to be, inadequately supported, tied or braced, whether before or during concrete placement operations, the County Engineer may require that the operation be stopped until the apparent defects have been corrected.

8.2.2 Material

8.2.2.1 Except as specifically noted otherwise, forms shall be of lumber, plywood, metal, plastic or a combination of the above, which shall produce the required surface finish. All material shall be free of defects, which materially affect form strength or impair the accuracy or appearance of the concrete surface. Prior to placing concrete, forms shall be coated with acceptable material to prevent bonding of concrete to the form.

8.2.2.2 Forms placed for successive pours for continuous surfaces shall be fitted to accurate alignment to assure smooth, completed surface free from irregularities and shall be sufficiently tight to prevent loss of mortar. No forms shall be left permanently in place without prior approval of the County Engineer. Holes resulting from removal of form ties shall be filled solid within 12 hours after removal of forms with cement grout, using the same cement and sand as used in the concrete.

8.3 Materials

8.3.1 General

The Contractor shall be responsible of obtaining concrete mix designs, obtaining and testing of concrete components, and field testing of concrete. Field testing of concrete includes tests for slump, air content, temperature, casting test cylinders, and obtaining test results. The testing laboratory used shall be AASHTO accredited and approved by the County Engineer. All test results shall be submitted to the County Engineer in a timely manner for approval.

8.3.2 Cement

8.3.2.1 Only one type of cement shall be used for exposed concrete in any individual structure.

8.3.2.2 Type I Portland cement to be used in all concrete unless otherwise directed.

8.3.2.3 Type II Portland cement shall be used where concrete will be in contact with the sanitary sewer.

8.3.3 Fine Aggregate

Fine aggregate shall consist of clean, hard natural sand manufactured sand or a combination thereof, conforming to ASTM C-33, concrete aggregates, and shall be graded from 3/8 inch to No. 100 sieve.

8.3.4 Coarse Aggregate

Coarse aggregate shall consist crushed stone, gravel or a combination thereof, conforming to ASTM C-33, concrete aggregates, and shall be graded to meet the requirements of size No. 467 and 67 as appropriate.

8.3.5 Water

Water shall be clean, free from oils, acids, salt, or other injurious substances.

8.3.6 Admixtures

Admixtures not listed in the approved concrete mix designs shall be used only with prior written approval.

8.3.7 Curing

Curing compound shall conform to Georgia Department of Transportation, Qualified Products List (QPL), for clear or white pigmented curing compound.

8.3.8 Reinforcing Steel

Reinforcing steel for concrete shall conform to ASTM A-615 Grade 60. Mesh reinforcement shall conform to ASTM A-185. All splices shall be lapped 30 diameters unless otherwise specified.

8.3.9 Preformed Expansion Joint Filler Strips

Preformed Expansion Joint Filler Strips shall conform to ASTM D-1751.

8.3.10 Vapor Barriers

Vapor barriers of 6-mil polyethylene shall be provided under all building floor slabs.

8.4 Concrete Quality

8.4.1 Strength

All concrete quality shall be classified by strength. The strength classification shall be 28-day minimum compressive strength.

8.4.2 Slump and Air Content

The slump and air content shall conform to the specified limits noted in the approved concrete mix designs.

8.4.3 Water - Cement Ratio

The water cement shall conform to the specified limits noted in the approved concrete mix designs.

8.4.4 Ready Mix

Ready mix concrete shall conform to Section 500 of the Georgia Department of Transportation Standard Specifications.

8.4.5 Strength

8.4.5.1 Sidewalks, manhole slabs, curbs, gutters, and ditch paving shall be 3000 psi.

8.4.5.2 Flowable fill shall have a minimum compressive strength of 100 psi.

8.5 Construction

8.5.1 Placing

8.5.1.1 All weather and temperature restrictions on placing the concrete shall be in conformance with Section 500 of the Georgia Department of Transportation Standard Specifications for structural concrete or Section 441 of the Georgia Department of Transportation Standard Specifications for miscellaneous concrete.

8.5.1.2 The maximum time that the concrete may be held in the truck shall conform to Section 500 of the Georgia Department of Transportation Standard Specifications.

8.5.1.3 Concrete shall be placed in the forms and mechanically vibrated to produce concrete without segregation or honeycomb. Slabs inclusive with beams shall be placed in one operation. Concrete shall be placed continuously between construction joints. Each batch shall be placed into the edge of previously placed concrete to avoid stone pockets and segregation. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated by mechanical vibration. During the casting of wall sections, not less than two mechanical vibrators shall be operated continuously for each casting section. The concrete shall not be freely dropped more than six feet, nor be moved horizontally after being deposited, more than five feet. Care must be taken to avoid excessive vibration. Do not allow the vibrators to come into contact with the reinforcing material.

8.5.2 Floating

The concrete shall be brought to correct level with a straight edge and struck off. Bull floats shall be used to smooth the surface of the slabs. Power floating of the slabs shall begin when the water sheen has disappeared and/or the mix has set sufficiently to support the weight of equipment.

8.5.3 Reinforcing Steel

Reinforcing steel shall be free from scale, oil, and structural defects. The retaining system shall insure that all reinforcing steel in the top surface will be of adequate support to prevent displacement. All reinforcing steel within the limits of a day's pour shall be in place and adequately tied before concrete placement begins. Pulling up reinforcement to the proper elevation during the placement of concrete shall not be allowed.

8.5.4 Construction Joints

Construction joints shall be formed at the locations shown on the plans. Joints, which must be formed in other locations, shall be water-stopped where appropriate, and be adequately keyed and doweled to form a horizontal or vertical line.

8.5.5 Curing and Protection

8.5.5.1 All freshly placed concrete shall be protected from the detrimental effects of the elements – freezing, rapid temperature loss, loss of moisture, and from future construction operations. The concrete shall be cured in accordance with Section 500 of the Georgia Department of Transportation Standard Specifications for structural concrete or Section 441 of the Georgia

Department of Transportation Standard Specifications for miscellaneous concrete.

8.5.5.2 Alternatively, all surfaces not protected by forms nor covered with water for the entire curing period shall be covered with curing compound meeting requirements of Section 8.3.6 of these Specifications. If a floor is left uncovered during the curing period, a film of water shall be clearly visible at all times on the entire surface of the slab. Other curing methods may be acceptable, but shall be approved by the County Engineer.

8.5.6 Removal of Forms

The forms shall not be removed until the concrete has attained sufficient strength to prevent cracking or other damage. When forms are removed, the Contractor shall take appropriate measures to prevent damage to the concrete by construction loads. It is the Contractor's responsibility to protect the concrete.

8.5.7 Backfilling

8.5.7.1 The County Engineer shall be notified 48 hours before backfilling in order that the work may be inspected before it is covered.

8.5.7.2 Backfilling shall not begin until all forms have been removed and trash and debris have been removed from the excavation.

8.5.7.3 Symmetrical backfill loading shall be maintained. Special care will be taken to prevent any wedging action or eccentric loading upon or against the structure.

8.5.7.4 Compaction shall be in accordance with Section 3.3 of these Specifications.

8.6 Concrete Finishes

8.6.1 Rough Finish

8.6.1.1 All concrete wall surfaces which are not exposed to view may be given this finish. This finish has as a prerequisite, a thoroughly vibrated concrete which will give a surface smooth, free from air pockets, water pockets, sand streaks, or honeycombs.

8.6.1.2 After the removal of forms, all fins shall be cut off; all holes, depressions, and rough spots shall be carefully pointed up with grout having the same proportions of cement and sand as used in the concrete being treated. The surface film of all pointed surfaces shall be carefully removed before

setting occurs, otherwise, surfaces shall be left with the texture imparted by the forms.

8.6.2 Rubbed Finish

8.6.2.1 Wall, beam, sill and under slab surfaces which are exposed to view shall have a rubbed finish. As soon as the rough surface finish has set sufficiently, the entire surface shall be wet with a brush and rubbed with a No. 16 carborundum stone, to bring the surface to a paste. The rubbing shall continue until all form marks and projections are removed, and to produce a smooth dense surface without pits or irregularities. The material, which is ground to a paste in the above process, will be carefully spread or brushed uniformly over the entire surface and allowed to "reset".

8.6.2.2 The final finish shall be obtained by a thorough rubbing with No. 30 carborundum stone. This rubbing shall continue until the entire surface is of a smooth texture and uniform in color. The surfaces shall be stripped evenly with a brush so as to remove excess paste, and the surface left smooth with only enough paste remaining to obtain a uniform color.

8.6.3 Float Finish

The surface of all concrete slabs shall, unless otherwise hereinafter specified, be given a float finish. The structural slab shall be brought to the established grade by screeding. Irregularities shall be eliminated and the entire surface finished with a hand float or finishing machine to within ±1/16 inch.

8.6.4 Broom Finish

Surfaces of exterior walkways or platforms shall be given a broom finish. A smooth, true, and uniform surface is required for this finish. When the progress of the set provides the proper consistency, the surface shall be raked with a broom to give parallel transverse lines in the surface, and to give a uniform texture.

8.6.5 Trowel Finish

All interior finish shall be machine troweled and hand troweled. Machine trowelling shall begin as soon as little or no cement past slings to the blade. Trowelling shall be continued until the surface is dense, smooth, and free of all minor blemishes, such as trowel marks. Hand trowelling shall be required to remove slight imperfections left by the trowelling machine and to bring the surface to a dense smooth finish.

Sprinkling of dry cement and mixture or dry cement on the surface of the fresh concrete shall not be permitted.

8.6.6 Polished Finish

Prior to polishing or hard trowel finishing, the surface must be finished in accordance with Section 8.6.5. The additional hand trowelling required for

this finish shall bring the surface to a smooth polished finish. Final hand trowelling shall continue until a clear ringing sound is heard as the trowel passes over the surface.

8.7 Samples and Testing

8.7.1 Description

The Contractor shall be responsible for the concrete mix designs, test cylinders for proving the mix designs, tests for the aggregate gradation and quality, for molding test cylinders during the progress of the job, delivering the cylinders for testing to a laboratory, approved by the County Engineer, testing for slump and air content, and for conducting load tests, if required.

8.7.2 Test Cylinders

One set of three concrete test cylinders shall be cast per each 50 cubic yards of concrete placed, for each class of concrete used. Cylinders shall be cured in accordance with ASTM C-31. The cylinders shall be tested for 28 day minimum compressive strength. All test reports shall be submitted to the County Engineer in a timely manner for approval.

In the event that concrete test cylinders do not meet the 28 day minimum compressive strength requirement, the Design Engineer shall submit a Corrective Action Plan to the County Engineer for approval.

The County Engineer reserves the right to cast additional concrete test cylinders as needed.

8.7.3 Slump

Slump test shall be performed whenever concrete test cylinders are cast. The County Engineer reserves the right to request additional slump tests, based on visual inspection of the mix.

Any failing test shall result in rejection of the load.

8.7.4 Air Content

Air content test shall be performed whenever concrete test cylinders are cast. The County Engineer reserves the right to request additional air content tests, at his discretion.

Any failing test shall result in rejection of the load.

8.7.5 Temperature

Temperature test shall be performed whenever concrete test cylinders are cast. The County Engineer reserves the right to request additional temperature tests, based on environmental conditions.

Any failing test shall result in rejection of the load.

8.8 Concrete Repairs

The Contractor is responsible for correction of concrete work which does not conform to specifications, including, but no limited to, strength, honeycomb, spalls, cracks, chips, holes, fins, tolerances, and finished. The County Engineer shall determine the acceptability of the proposed method of repair.

9.0 CONSTRUCTION OF CONCRETE CURB AND GUTTER

9.1 Description

This section covers the construction of Portland cement concrete curb and gutter section, including furnishing all labor, equipment, materials, and appliances whatsoever required to complete the work in accordance with these Specifications.

9.2 Utilities

All utilities shall be in place and in final configuration prior to the placement of concrete curb and gutter.

9.3 Portland Cement Concrete Curb and Gutter

9.3.1 Dimensions

Size and dimensions of curb and gutter shall conform with Standard Drawing 9-1.

9.3.2 Concrete

9.3.2.1 Concrete shall have a minimum compressive strength of 3000 psi at 28 days.

9.3.2.2 All concrete equipment, workmanship, and materials shall conform to the applicable requirements of Section 8 of these Specifications, except as hereinafter specified.

9.3.2.3 Concrete shall conform with Section 8.4 of these Specifications.

9.3.3 Base Preparation

9.3.3.1 The base shall be constructed true to line, grade, and cross section. The base shall be of materials meeting applicable specifications of Section 4 of these Specifications in regard to material quality, compaction, testing, etc. The base for curb and gutter shall extend in all cases at least six inches behind the back of curb.

9.3.3.2 The base shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade.

9.3.4 Forms

9.3.4.1 The forms shall straight and true, without any defects, which adversely affects the appearance or strength of the curb, and of sufficient strength to resist springing during depositing and consolidating the concrete.

9.3.4.2 Flexible or curved forms shall be used in curves and radii, as necessary, to allow for a smooth curve and to prevent a chord effect in the alignment.

9.3.4.3 Prior to use, all forms shall be thoroughly cleaned and coated with acceptable material to prevent bonding of the concrete to the form.

9.3.5 Powered Curb Formers

9.3.5.1 Powered curb formers shall be in good working and able to produce curb that is smooth and uniform.

9.3.6 Joints

9.3.6.1 Expansion joints and contraction joints shall be constructed at right angles to the line of curb and gutter.

9.3.6.2 Contraction joints shall be placed so that monolithic sections of curb and gutter shall not be less than 5 feet nor more than 10 feet in length and shall be uniformly placed.

9.3.6.3 The depth of the contraction joint shall be a minimum of ¼ inch in depth and shall be placed as soon as practical without causing damage to the concrete. Separators shall be removed as soon as practicable after the concrete has set sufficiently to preserve the width and shape of the joint.

9.3.6.4 Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of the curb and gutter.

9.3.6.5 Expansion joint filler, unless otherwise specified, shall conform to Georgia Department of Transportation, QPL.

9.3.6.6 Expansion joints shall be provided in curb and gutter at the ends of all returns, at catch basins, cold joints, and at intervals not to exceed 50 feet.

9.3.7 Construction

9.3.7.1 All weather and temperature restrictions for the concrete shall be adhered to in accordance with Section 441 of the Georgia Department of Transportation Standard Specifications.

9.3.7.2 All new construction of concrete curb and gutter, which adjoins existing curb and gutter, shall begin at the joint of the first section of existing curb and gutter in good condition, or as determined by the County Engineer. The Contractor shall bear all costs occurring from the removal of existing unsuitable curb and gutter.

9.3.7.3 Concrete shall be placed to the required depth and thoroughly consolidated so that there are no rock or air pockets at forms and mortar entirely covers the surfaces. Concrete may be compacted by means of mechanical vibrators. Concrete shall not be free dropped from a height so as to cause segregation.

9.3.7.4 The curb and gutter shall conform to meet Standard Drawing 9-1 with and edging tool to radii on exposed edges, and the surfaces floated and finished with a smooth float until true to grade and section and uniform in texture. The floated surfaces shall then be brushed with a fine hair brush with longitudinal strokes.

9.3.7.5 Visible surfaces and edges of the finished curb and gutter shall be free of blemishes, form and tool marks, and shall be uniform in color, shape, and appearance.

9.3.7.6 All camera inspections and subsequent repairs shall be complete prior to installation of cement stabilized subgrade and curb on all projects.

9.4 Testing

9.4.1 Sampling and Testing

Sampling and testing shall be done in accordance with Section 8.7 of these Specifications, or as directed by the County Engineer.

9.4.2 Notification

The Contractor shall notify the County Engineer at least 48 hours prior to concrete placement. No concrete shall be placed prior to inspection of the base by the County Engineer.

9.4.3 Tolerances

The finished surfaces, except plan grade changes or curves, shall not vary from plan line and grade by more than 1/4 inch per ten feet in the curb and gutter.

9.5 Finishing and Protection

9.5.1 Backfill

After the concrete has set sufficiently, the area to be backfilled shall be cleaned of debris and the backfill shall be placed in accordance with Section 8.5.7 of these Specifications.

9.5.2 Protection

The Contractor shall protect the completed curb and gutter from all damage until accepted. Curb and gutter, which has settled due to base settlement or erosion under cut or has been cracked or broken, shall be removed and replaced in accordance with the above specifications.

9.5.3 Repair

All minor repairs or defects shall be filled with mortar composed of one part Portland cement and two parts sand, or as directed by the County Engineer. Plastering shall not be allowed.

9.5.4 Damage

Any damaged curb and gutter that is deemed unacceptable by the County Engineer, shall be removed, and replaced for the entire length between contraction and expansion joints.

9.6 Protection of Exiting Service Lines and Utilities

Protection of existing service lines shall be performed in accordance with Section 4.4 of these Specifications.

9.7 Restoration of Property

Restoration of property shall be performed in accordance with Section 4.5 of these Specifications.

10.0 CONCRETE SIDEWALKS AND DRIVEWAYS

10.1 General

This specification covers the general requirements for the construction and reconstruction of concrete sidewalks and driveways.

10.2 Utilities

All utilities shall be in place and in final configuration prior to the placement of concrete sidewalk and driveways.

10.3 Concrete sidewalks

10.3.1 Size and Dimensions

10.3.1.1 Concrete sidewalks size shall conform to Standard Drawing 10-1.

10.3.1.2 Concrete sidewalks shall be a minimum of 5 feet wide and 4 inches thick, except at driveways where it shall be 6 inches thick, tapered 1 inch on each side of the driveway.

10.3.2 Material

Concrete shall have a minimum compressive strength of 3000 psi at 28 days and shall meet all applicable specifications of Section 9.3.2.

10.3.3 Preparation of Base

10.3.3.1 Base shall be prepared in accordance with all applicable specifications of Section 3.3 inclusive, with the following changes.

10.3.3.2 Base shall be compacted to 95% maximum dry density, standard proctor.

10.3.4 Forms

10.3.4.1 Forms shall be straight and true, without any defects, which adversely affect the appearance or strength to resist springing during depositing and consolidating the concrete.

10.3.4.2 Forms shall have a height equal to the full depth of the sidewalk.

10.3.4.3 Forms shall be held rigidly in place.

10.3.4.4 Flexible or curved forms shall be used in curves and radii, as necessary, to allow for a smooth curve and to prevent a chord effect in the alignment.

10.3.4.5 Forms shall not be removed in any case while the concrete is sufficiently plastic to slump in any direction.

10.3.4.6 Prior to use, all forms shall be thoroughly cleaned and coated with acceptable material to prevent bonding of the concrete to the form.

10.3.5 Joints

10.3.5.1 Expansion joint filler, unless otherwise specified, shall conform to Georgia Department of Transportation, QPL.

10.3.5.2 Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of the sidewalk and shall not extend more than ½ the thickness of the sidewalk below the level surface of the sidewalk.

10.3.5.3 Expansion joints shall be provided in the sidewalk at the ends of all returns, at catch basins, cold joints and at intervals not to exceed 50 feet.

10.3.5.4 Contraction joints shall be placed not less than 5 feet in length or as directed by the County Engineer.

10.3.5.5 The depth of the contraction joint shall be a minimum of ¼ inch in depth and shall be placed as soon as practical without causing damage to the concrete.

10.3.6 Construction

Construction shall be in accordance with Section 9.3.7, as it applies to concrete sidewalks and driveways.

10.3.7 Finish and Protection

10.3.7.1 Sidewalks shall be finished with floats and final finished with transverse strokes of a stiff bristle broom.

10.3.7.2 The Contractor shall ensure and be responsible for protection of the sidewalk from pedestrian traffic, vandalism, and weather in addition to other damage during the curing period.

10.3.7.3 After the concrete has cured sufficiently, the area to be backfilled shall be cleaned of debris and fill shall be placed as required.

10.3.7.4 The Contractor shall be responsible for the protection of the complete sidewalk from any and all damages whatsoever until it has been accepted by the County Engineer. Sidewalk which has cracked, settled, or been displaced will not be accepted by the County Engineer.

10.3.7.5 Sidewalks that are damaged, shall be removed and reconstructed for the entire length between contraction and expansion joints.

10.4 Driveways

10.4.1 Sidewalk

10.4.1.1 Sidewalk shall match grade to existing concrete and asphalt driveways so as not to present a hazard or unsightly appearance.

10.4.1.2 Sidewalk shall be placed across unimproved driveways at the plan grade.

10.4.2 Access

Access shall be in accordance with Section 7.4 of these Specifications.

10.5 Testing

10.5.1 Specifications

Testing shall be done in accordance with Section 8.7 of these Specifications, or as directed by the County Engineer.

10.5.2 Inspection

The Contractor shall notify the County Engineer at least 48 hours prior to placing concrete. No concrete shall be placed without inspection of the base by the County Engineer.

10.5.3 Tolerances

The finished surfaces, except at plan grade or line changes, shall vary no more than ¼ inch in 10 feet for the top and face of sidewalk from plan grade and line.

10.6 Protection of Existing Service Lines and Utilities

Protection of existing service lines shall be performed in accordance with Section 4.4 of these Specifications.

10.7 Restoration of Property

Restoration of property shall be performed in accordance with Section 4.5 of these Specifications.

10.8 Reconstruction or Adjustment to Grade of Miscellaneous Structures

Reconstruction or adjustment to grade of miscellaneous structures shall performed be in accordance with Section 4.6 of these Specifications.

10.9 Drainage

10.9.1 General

The Contractor shall be responsible for retaining all drainage characteristics of the project, unimpeded at all times, and through acceptance of the work.

10.9.2 Ditches

The Contractor shall be responsible for the relocation and/or construction of all drainage ditches or swales as shown on the plans or as required by the County Engineer.

10.9.3 Driveway Pipes (Side Drains)

The Contractor shall be responsible for the relocation of all driveway pipes or side drains as shown on the plans or as directed by the County Engineer.

11.0 CONSTRUCTION OF STORM DRAIN PIPE SYSTEM

11.1 Description

The work covered by this section of the specifications consists of furnishing and in performing all operations, necessary and incidental to the construction and installation of storm drain pipe. This shall include, but not be limited to all excavation, trenching, removal, and replacement of unsuitable materials, grading, all pipe, and fittings, as shown on the Project Documents.

11.2 Plans, Permits and Codes

11.2.1 Permits and codes

It is the intent of this section of the specifications that the Contractor's bid on this work be based upon the Project Documents and with all applicable codes, permits and regulations.

11.2.2 Plans

11.2.2.1 The Project Documents indicate the extent and specific arrangement of the work.

11.2.2.2 If any departure from the indicated line, grade or location as shown by the plans are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted by the Design Engineer to the County Engineer as soon as practicable for approval.

11.2.2.3 No work on such departures or deviations shall begin without written approval from the County Engineer. No work shall be accepted by the County Engineer with any unapproved departures or deviations from the Project Documents.

11.3 Materials

11.3.1 General

11.3.1.1 All materials furnished by the Contractor shall meet the requirements of these Specifications.

11.3.1.2 All materials shall be new, first quality and free from any and all defects and blemishes such as cracking, splitting, spalling, damages to coatings, bending, dents, and deformations of any type. Material shall be protected from damage at all times.

11.3.1.3 The materials may be inspected at any time and all material deemed unsuitable or damaged, shall either be satisfactorily repaired or removed from the project, easement, or limits of construction. All repairs shall be approved by the County Engineer.

11.3.1.4 Extreme care shall be exercised in handling the material during unloading, storing and at all times during construction. All unloading or placing of pipe in the trench shall be done carefully by hand or machine. At no time will materials be allowed to free fall or be dropped from any height.

11.3.2 Pipe Specifications

Except as otherwise approved, pipe for storm drains shall be reinforced concrete pipe (RCP) or polypropylene pipe (PP) (in limited applications per GDOT QPL for all applications within the right of way and drainage easements). Smooth-lined corrugated polyethylene (PE) culvert pipe or double walled high density polyethylene pipe (HDPE) may be used for private applications and will not be accepted by County as public infrastructure.

A. Reinforced Concrete Pipe (RCP):
   a. Pipe shall meet or exceed the requirements of ASTM C- 76.
   b. Minimum pipe size shall be 18 inches.
   c. Gasketed pipe shall be used for all roadway crossings.
   d. Pipe class and minimum cover shall be determined by Design Engineer and approved by the County Engineer.

B. Polypropylene (PP) Pipe:
   a. Pipe shall meet or exceed the requirements of ASTM F2881 and AASHTO M330.
   b. Minimum pipe size shall be 18 inches.
   c. Pipe shall have smooth interior walls and annular exterior corrugations.
   d. Minimum pipe cover shall be determined by Design Engineer and approved by the County Engineer.

C. Smooth-Lined Corrugated Polyethylene (PE) Pipe:
   a. For private use only. Not allowable within County-owned right-of-way.
   b. Type “S” pipe diameter sizes 18” to 26” shall meet or exceed the requirements of AASHTO M294.
   c. Type “S” pipe diameter sizes 42” and 48” shall meet or exceed the requirements of AASHTO MP6-95.
   d. Minimum pipe cover shall be determined by Design Engineer and approved by the County Engineer.

D. High-Density Polyethylene (HDPE) Pipe:
   a. For private use only. Not allowable within County-owned right-of-way.
   b. Type “S” or Type “D” smooth interior walls shall meet or exceed the requirements of AASHTO M-252, M-294, and MP6-95.
   c. Installation shall be in conformance with ASTM D 2321.
   d. Minimum pipe cover shall be determined by Design Engineer and approved by the County Engineer.

11.3.3 Fittings and Bands

All fittings and bands shall be factory produced first quality and shall be designed for installation on the pipe to be used and be of the same quality and material as the pipe to be used. The fittings and couplings shall comply with the joint performance criteria of AASHTO Standard Specifications for Highway Bridges, Division II.

11.3.4 Weep Holes

Weep hole pipe shall be minimum schedule 40 PVC meeting ASTM D1785 Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120, or D2665 Standard Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

11.3.5 Affidavit of Compliance

The Contractor shall furnish an affidavit from the manufacturer that all material conforms to the above referenced ASTM or AASHTO Specifications to the County Engineer.

11.4 Excavation, Trenching and Backfill for Pipelines

11.4.1 General

The work covered by this specification consists of furnishing all labor, equipment, and materials in performing all operations in connection with the excavation, trenching, and backfilling for pipelines in strict accordance with the Project Documents.

11.4.2 Classification of Excavation

The term “excavation” used hereinafter is defined as “unclassified excavation”. Excavation of every type and description regardless of material encountered shall be constructed to the lines and grades as indicated on the plans or as directed by the County Engineer.

11.4.3 Excavation for Storm Water Structures

Excavation for walls and footings shall extend a sufficient distance to allow for the placing and removal of forms, installation of services and for inspection, except where the wall or footing may be authorized to be placed directly against excavated surfaces.

11.4.4 Trench Excavation for Storm Water Pipe

11.4.4.1 General

Trenches shall be excavated true to line and grade regardless of substances or material encountered and after the right-of-way, easement, or limits of

construction have been cleared, grubbed and graded to sub-base or plan line and grade.

11.4.4.2 Trench Width

Trenches shall be excavated to a sufficient width for proper placement of pipe and to ensure proper compaction of the backfill material in accordance with the Project Documents and all OSHA Regulations.

11.4.5 Trench Foundation

11.4.5.1 Preparation

Trenches shall be excavated accurately to plan grade to provide a uniform and stable foundation. Any undercut shall be replaced with approved material which is suitable from the undercut or select fill placed and compacted to 95% of maximum dry density, as per Section 3.3.1 of these Specifications.

All fill material shall be free of trash, lumber, debris, objectionable material, rock greater than 1 ½ inches in diameter, frozen or wet material, roots or other organic, perishable or detrimental matter.

11.4.6 Bell Holes

Bell holes shall be dug at each bell or coupling so that load is supported entirely by the pipe barrel, uniformly throughout its entire length, on the prepared bottom of the trench. Bell holes shall be excavated only to an extent sufficient to permit accurate work in the making of the joints.

11.4.7 Rejection

Any and all pipe which is not uniformly supported throughout its entire length shall be removed and the trench bottom reshaped and compacted to plan line and grade so as to support the pipe uniformly. There shall be no voids visible anywhere below the pipe.

11.4.8 Unsuitable Foundation

11.4.8.1 Where the natural trench bottom is incapable of satisfactorily supporting the pipe, such unsuitable soil shall be removed to a minimum depth of 6” and shall be filled with material suitably compacted and reshaped to plan line and grade so as to support the pipe uniformly throughout its length, as approved by the County Engineer.

11.4.8.2 Where rock excavation is required, the rock shall be excavated a minimum of 1 foot below the plan grade of the pipe. Select fill shall then be placed and compacted in accordance with Section 11.4.9.2.

11.4.9 Backfilling and Compaction

11.4.9.1 The backfilling shall not begin until necessary inspections and tests have been performed and inspected by the County Engineer.

11.4.9.2 All pipe backfill shall be placed in uniform, horizontal, 8 inch loose layers and compacted to 95% maximum dry density.

11.4.9.3 After pipe is laid in the prepared trench bottom, suitable material shall be placed in symmetrical and uniform layers and compacted under the pipe haunches to the spring line and carefully compacted in conformance with the Project Documents. Only enough material to backfill to the spring line shall be placed in the trench and compacted until compaction of the haunches has been attained. Extreme care will be exercised by the Contractor to attain the desired compaction without displacing the pipe. Typical trench section shall conform to Standard Drawings 1-7 and 1-8.

11.4.9.4 When compaction has been attained at the pipe haunches, the Contractor shall begin the initial backfill to the top of the pipe, placing material symmetrically and uniformly so as to prevent displacement of the pipe.

11.4.9.5 The remainder of the trench zone shall be carefully placed and compacted by mechanical tampers. Proper compaction shall be obtained without causing any damage to the pipe.

11.4.10 Dewatering and Drainage

11.4.10.1 Grading

All grading in the vicinity of the trench excavations shall be controlled to prevent surface ground water from flowing into the trenches.

During excavation, material suitable for backfilling shall be stored in an orderly manner and safe distance from the excavation as to prevent slides or cave-ins, in accordance with OSHA Regulations.

11.4.10.2 Dewatering

Where water is encountered, it shall be prevented from accumulating in excavated areas by pumping, well pointing, or other acceptable means. Water so removed shall be discharged in a manner and location so as not to cause injury or damage to public or private property, work in progress, or completed work and in accordance with all environmental guidelines

Under no circumstances will pipe be laid in accumulated water. Where ground water table is such that it makes well pointing impractical, the Contractor shall bed the pipe in stone to the extent necessary to provide a dry trench bottom.

11.4.11 Shoring and Sheeting

11.4.11.1 Description

All shoring, sheeting, and bracing required to perform and protect the excavation and to safeguard employees and the public shall be performed. The Contractor shall comply with all OSHA Regulations for all trenching, shoring, and sheeting operations during construction.

11.4.11.2 Responsibility

The Contractor shall be responsible for the placing of such protection as necessary and shall be responsible for any damages resulting from its omission.

11.4.11.3 Removal

Whenever sheeting is driven to a depth below the elevation of the top of the pipe, that portion of the sheeting below the elevation of the top of the pipe shall not be disturbed or removed. Sheeting left in place shall be cut off not less than one foot below finish grade. No sheeting shall be removed until the excavation is substantially backfilled. Excluded from this requirement are specially constructed reusable shoring devices.

11.4.12 Blasting

11.4.12.1 Requirements

All explosives used within the right of way, easement, or limits of construction shall be done in strict accordance with all state and federal regulations.

11.4.12.2 Responsibility

It is the Contractor's responsibility to ensure the compliance with Section 11.4.12.1 of these specifications and is solely responsible for any kind and all damage resulting from blasting operations.

11.4.12.3 Notification

The County Engineer and Columbia County Public Relations Manager shall be notified 48 hours prior to any blasting.

11.4.13 Testing

11.4.13.1 Testing

The pipe backfill shall be tested for compaction. The length of pipe between two catch basins shall be considered a section requiring testing. In each section, compaction testing shall be performed on every other lift of backfill up to within 1 foot of subgrade elevation.

All test reports shall be submitted in accordance Section 1.9 of these Specifications.

The County Engineer reserves the right to perform additional testing, as needed.

11.4.14 Protection of Existing Services Lines

The Contractor shall be responsible for the protection of existing service line and utilities in accordance with Section 4.4 of these Specifications.

11.4.15 Restoration of Property

The Contractor shall be responsible for the restoration of property in accordance with Section 4.5 of these Specifications.

11.4.16 Removal and Replacement of Existing Pipes and Equipment

Where shown on the plans or drawings or where required to properly construct the work under the contract, the Contractor shall remove and replace such pipelines and equipment or structures as directed by the County Engineer.

11.4.17 Pavement Removal and Replacement

11.4.17.1 Open Cuts

No open cuts of pavement on county roads shall be made without prior written approval of the County Engineer.

Certain roads will require a permit from Georgia Department of Transportation. No work shall begin until receipt of the Georgia DOT permit.

11.4.17.2 Repair

The Contractor shall be responsible for the repair of pavement in streets and driveways in accordance with Standard Drawings 1-9 and 1-10.

Concrete driveways and sidewalks shall be saw cut either side of the limit of excavation or the concrete shall be removed to the nearest joint. The trench shall be backfilled and compacted in accordance with the above Specifications and concrete of 3000 psi compressive strength shall be placed monolithically 9 inches on either side of the trench. The thickness of the concrete over the trench shall not be less than 6 inches for driveways or not less than 4 inches for sidewalks. The concrete shall be placed to align with the grade of the existing driveway and sidewalk in the areas of the repair.

11.4.18 Finish Grade

11.4.18.1 Drainage

The Contractor shall be responsible for maintaining all ditches, drains, and culverts on the right of way, easement, or limits of construction and for ensuring the effective functioning of all existing drainage characteristic.

11.4.18.2 Responsibility

The Contractor shall be responsible for all damage to property, public, or private, resulting from the above.

11.5 Construction

11.5.1 Pipe Laying

11.5.1.1 Only such pipe as has been previously inspected and approved, is free of dents, spalls, cracks and is free from any damage which may, be detrimental to the proper functioning of the storm drain system, shall be laid in the trench.

11.5.1.2 The Contractor shall remove from the site all damaged material.

11.5.1.3 Pipe shall be carefully lowered into the trench; no pipe shall be free dropped into the trench.

11.5.1.4 The pipe laying shall proceed upgrade with the spigot end of bell and spigot pipe pointing in the direction of the flow.

11.5.1.5 Each pipe shall be laid true to line and grade in such manner as to form a close concentric joint with the adjacent pipe and to prevent offsets in the flow line.

11.5.1.6 The pipe shall be kept clean and free of debris at all times.

11.5.2 Jointing

11.5.2.1 Reinforced concrete pipe sections may be joined by mortar joints, bituminous plastic cement joints, rubber type gasket joints, O-Ringed gasket joints or preformed plastic gasket joints. In mortar and bituminous plastic cement joints the annular space shall be filled with the joint material and the inside of the joint wiped smooth. Mortar joints shall be made in the same manner except that the annular space shall be thoroughly wetted before filling with joint material. After the initial wet, the mortar on the outside shall be protected from the air and sun with thoroughly wet over**.**

11.5.2.2 HDPE shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable,

protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. Joints shall have an exterior bell wrap installed as recommended by the manufacturer.

11.5.2.3 PP shall be joined with a gasket, integral bell, and spigot joint, meeting the requirements of ASTM F2881. Joints shall be watertight according to the requirements of ASTM D3212. Spigots shall have gaskets meeting the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during joint assembly. Joints shall have an exterior bell wrap installed as recommended by the manufacturer.

11.6 Tie-in to Existing Storm Drains

11.6.1 Authorization

11.6.1.1 At no time shall the Contractor make any unauthorized tie-ins of storm drains of any type under construction to existing storm drains of any type.

11.6.1.2 The Contractor shall not make any authorized tie-ins (e.g. called for on the Project Documents or previously approved changes) unless the County Engineer is present.

11.6.2 Construction

11.6.2.1 The Contractor shall make any such tie-ins in strict accordance with the Project Documents.

11.6.2.2 The Contractor shall take whatever measures are necessary to prevent the introduction of mud, silt, debris, or excess surface water runoff into the existing storm drain system.

11.6.2.3 Expediting Work- The Contractor shall excavate, lay the pipe, and backfill as closely together as possible. Unjointed pipe shall not be left in the trench overnight. The Contractor shall backfill and compact the trench as soon as possible after laying and jointing is completed. The exposed end of the installed pipe shall be covered with plywood or filter fabric each day at the close of work and at all other times when work is not in progress. If necessary to backfill over the end of an uncompleted pipe, the end shall be closed with a mechanical joint plug, however, backfilling shall commence only after inspection.

11.6.3 Field Tests

11.6.3.1 Pipe and Fittings

Each piece of pipe and fitting shall be visually inspected immediately before being placed in the trench and all pieces which are damaged and cannot be repaired after installation shall be rejected.

11.6.3.2 Joints Alignment and Grade

After the pipe has been installed in the trench and prior to backfill, the joints alignment and grade shall be carefully checked for conformance with the plans. Any protruding joint material shall be removed and the joint remade.

11.6.3.3 Visual Inspection

All storm drains shall be visually checked for alignment between structures and any deviations from the plan line and grade or offsets of any type shall cause that portion of the storm drain system to be rejected if said defects will adversely affect the designed performance of the system and shall be relayed correctly by the Contractor at the Contractor's expense.

11.6.3.4 All camera inspections and subsequent repairs shall be complete prior to installation of cement stabilized subgrade and curb on all projects.

11.7 Protection of Service Lines and Utilities

Protection of service lines and utilities shall be performed in accordance with Section 4.4 of these Specifications.

11.8 Restoration of Property

Restoration of property shall be performed in accordance with Section 4.5 of these Specifications.

11.9 Removal and Replacement of Existing Pipes and Equipment

Removal and replacement of existing pipes and equipment shall be in strict accordance with the Project Documents, or as directed by the County Engineer.

11.10 Pavement Removal and Replacement

Pavement removal and replacement shall be in strict accordance with the Project Documents, or as directed by the County Engineer.

11.11 Clean Up and Finishing

All pipe shall be clean and free from silt, mud, debris or anything which may block the free flow of water prior to acceptance.

12.0 CONSTRUCTION OF STORMWATER DRAINAGE STRUCTURES AND STORMWATER MANAGEMENT FACILITIES

12.1 General

The work covered by this section of the specifications consists of furnishing all labor, equipment, materials, and appliances and in performing all operations necessary and incidental to the construction of stormwater structures. This will include but not be limited to all excavation, trenching, removal, and replacement of unsuitable materials and grading as shown on the Project Documents.

12.2 Plans, Permits and Codes

12.2.1 Changes in Plan

12.2.1.1 The Project Documents indicate the extent and specific arrangement of the work.

12.2.1.2 The Contractor, in consultation with the County Engineer, may have reasonable leeway to make minor adjustments to grades and stormwater drainage system, excluding stormwater management facilities, in order to maintain project uniformity as long as the designed intent of the systems are not changed and positive drainage is maintained. Substantial changes shall be submitted by the Design Engineer for the approval by the County Engineer before implementation.

12.3 Excavation and Backfill

12.3.1 Excavation for Structures

All excavation shall be in strict accordance with Sections 3 and 8 of these Specifications.

12.3.2 Excavation for Stormwater Management Facilities

All stormwater management facilities shall be constructed in strict accordance with the Project Documents. Any deviations shall be approved by the County Engineer, prior to implementation.

12.3.3 Backfill for Structures

Backfill shall be constructed in strict accordance with Sections 3 and 8 of these Specifications.

12.3.4 Earth Fill for Stormwater Management Facilities

Earth fill shall be constructed in strict accordance with Sections 3 and 8 of these Specifications.

12.3.5 Structural Fill for Stormwater Management Facilities

Structural fill shall be constructed in strict accordance with the Project Documents.

12.3.6 Drainpipe through Stormwater Management Facilities

Drainpipe through stormwater management facilities shall be constructed in strict accordance with the Project Documents.

12.4 Construction of Stormwater Structures

12.4.1 Applicability

12.4.1.1 All stormwater structures shall be constructed in strict accordance with the appropriate Georgia Department of Transportation Standard Drawing, the appropriate Columbia County Standard Drawing, and the Project Documents.

12.4.2 Inspections

12.4.2.1 All stormwater structures shall be inspected by the County Engineer prior to acceptance for conformity with the specifications.

12.4.3 Drainage through Structures

12.4.3.1 All catch basins shall have weep holes installed per the Columbia County Standard Details.

12.5 Protection and Repairs

All stormwater structures shall be protected from damage until accepted. Any damage that may occur shall be repaired to the satisfaction of the County Engineer.

12.6 Clean up and Finishing

All stormwater structures shall be clean and free from silt, mud, debris or anything which may block the free flow of water prior to acceptance.

12.7 Protection of Service Lines and Utilities

Protection of service lines and utilities shall be performed in accordance with Section 4.4 of these Specifications.

12.8 Restoration of Property

Restoration of property shall be performed in accordance with Section 4.5 of these Specifications.

12.9 Reconstruction or Adjustment to Grade of Miscellaneous Structures

The Reconstruction or adjustment to grade of miscellaneous structures shall be performed in accordance with Section 4.6 of these Specifications.

13.0 EROSION AND SEDIMENT CONTROL

13.1 Applicability

13.1.1 Construction Standards and Specifications

Construction standards and specifications for Best Management Practices (BMPs) shall be in accordance with Georgia Soil and Water Conservation Commission's Manual for Erosion and Sediment Control in Georgia (Green Book), latest edition.

13.1.2 Authorization to Discharge Storm Water

Authorization to discharge storm water associated with construction activities to the waters of the State of Georgia shall be in accordance with Georgia Department of Natural Resources / Environmental Protection Division's National Pollutant Discharge Elimination System (NPDES).

13.1.3 Permitting, Inspection, Enforcement and Penalties

Permitting, inspection, enforcement, and penalties shall be in accordance with Columbia County's Code of Ordinances, Chapter 34, Article 3 – Soil Erosion, Sedimentation, and Pollution Control.

14.0 FENCING

14.1 Description

The work covered by this section of the specification consists of furnishing all labor, equipment, and materials, and in performing all operations in connection with the construction of the chain link fence, complete with all appurtenances, in strict accordance with this section of the specifications, the applicable drawings, and subject to the terms and conditions of the contract.

14.2 Materials

14.2.1 General

The fence shall have an overall height of 6 feet excluding the 3 strands of barbed wire on the top, arms inside. The fence shall be the standard product of Cyclone Fence Corp., or American Chain & Cable, Anchor Post Products, or equal.

14.2.2 Fabric

Fabric shall be No. 9 gauge, 2 inch mesh, Class I, galvanized in conformance with ASTM requirements.

14.2.3 Posts

Line posts, 2 inch O.D. shall be spaced not more than 10 feet. Corner and gate posts shall be 3 inch O.D. Posts shall be anchored in concrete footings, crowned to shed water.

14.2.4 Toprail

A 1 5/8 inch O.D. toprail shall be provided for the entire fence.

14.2.5 Fabric Reinforcing Wire

Fabric reinforcing wire shall be provided along the bottom edge. It shall be not less than No. 7 gauge coiled spring wire. Galvanized ties or clips shall be provided for attaching reinforcing wires to fabric at intervals of not more than 2 inches.

14.2.6 Post Braced

Nominal 1 5/8 inch O.D. galvanized tubular post braces extending to each adjacent line post at mid-height of the fabric shall be provided for each gate, corner, pull and end post. A 3/8 inch diameter truss rod shall also be provided from the line post back to the gate, corner, pull, or end post, with a turnbuckle or other equivalent provision for adjustment.

14.2.7 Stretcher Bars

Stretcher Bars 3/16 X 3/4 inch in size, with length 1 inch less than fabric height, shall be provided for stretching and securing the fabric at each gate,

end, corner and pull post, one for each gate and end post and two for each corner and pull post.

14.2.8 Post Tops

All posts shall be provided with post tops which will fit over the outside of posts to exclude moisture and shall be combination tops with barbed wire supporting arms. Post tops shall be provided with a hole suitable for the through passage of the top rail.

14.2.9 Barbed Wire Supporting Arms

Barbed wire supporting arms shall be at an angle of 45 degrees and shall be fitted with clips or other means for securing three lines of barbed wire, the top line approximately 12 inches horizontally from the fence line and 12 inches above the top of the fabric and the other lines spaced uniformly between the top line and the top of the fabric.

14.2.10 Barbed Wire

Barbed wire shall consist of 3 strands of 12 gauge wire with 14 gauge, 4 point barbs spaced approximately 5 inches apart. The wire shall be electrogalvanized. The barbs may be aluminum.

14.2.11 Ties or Clips

Ties and clips of adequate strength shall be provided in sufficient number for attaching the fabric to all line posts and to top rail at intervals not exceeding 15 inches

14.2.12 Bands and Clips

Bands and clips of adequate strength shall be provided in sufficient number for attaching the fabric and stretcher bars to all terminal posts at intervals not exceeding 15 inches.

14.2.13 Gates

Gates shall be swing-type complete with latches, stops, keepers, and hinges, with 3 strands of barbed wire mounted on vertical arms above the fabric. One double leaf gate for a minimum 14 feet opening is required.

14.2.13.1 Gate frames shall be constructed of galvanized tubular members, 3 inch O.D. at 2.72 lbs. for the double leaf 14 feet gate, and trussed and braced in such a manner as to provide a rigid frame and ample strength to insure a gate free from sag and twist, the end members of each frame shall be extended approximately 12 inches above the top member and arranged for attaching 3 uniformly spaced lines of barbed wire.

14.2.13.2 Stretcher bars shall be provided for each gate to facilitate tight installation of the fabric in each gate frame.

14.2.13.3 Ties, bands, and clips of adequate strength shall be provided in sufficient number for attaching the fabric to the frame and stretcher bars and the stretcher bars to the gate frame.

14.2.13.4 Hinges shall be of heavy pattern, of adequate strength for the gate, and with large bearing surfaces for clamping in position. The hinges shall not twist or turn under the action of the gate. The gates shall be capable of being open and closed easily by one person.

14.2.13.5 Latches, stops, and keeper shall be provided for all gates; the latches shall have the plunger bar arranged to engage the stops when closed and the keepers when open. Latches shall be arranged for locking by padlock. Center stops shall consist of a device arranged to be set in concrete and to engage the plunger of the latch bar of double gate. Keepers shall consist of a mechanical device for securing the free end of the gate when in fully open position, one being required for each gate leaf.

14.2.13.6 All metallic units or items shall be hot-dip galvanized finish except barbed wire which shall be electrogalvanized. Ties, clips and bands and barbed wire may be aluminum.

14.3 Installation

14.3.1 Post Setting

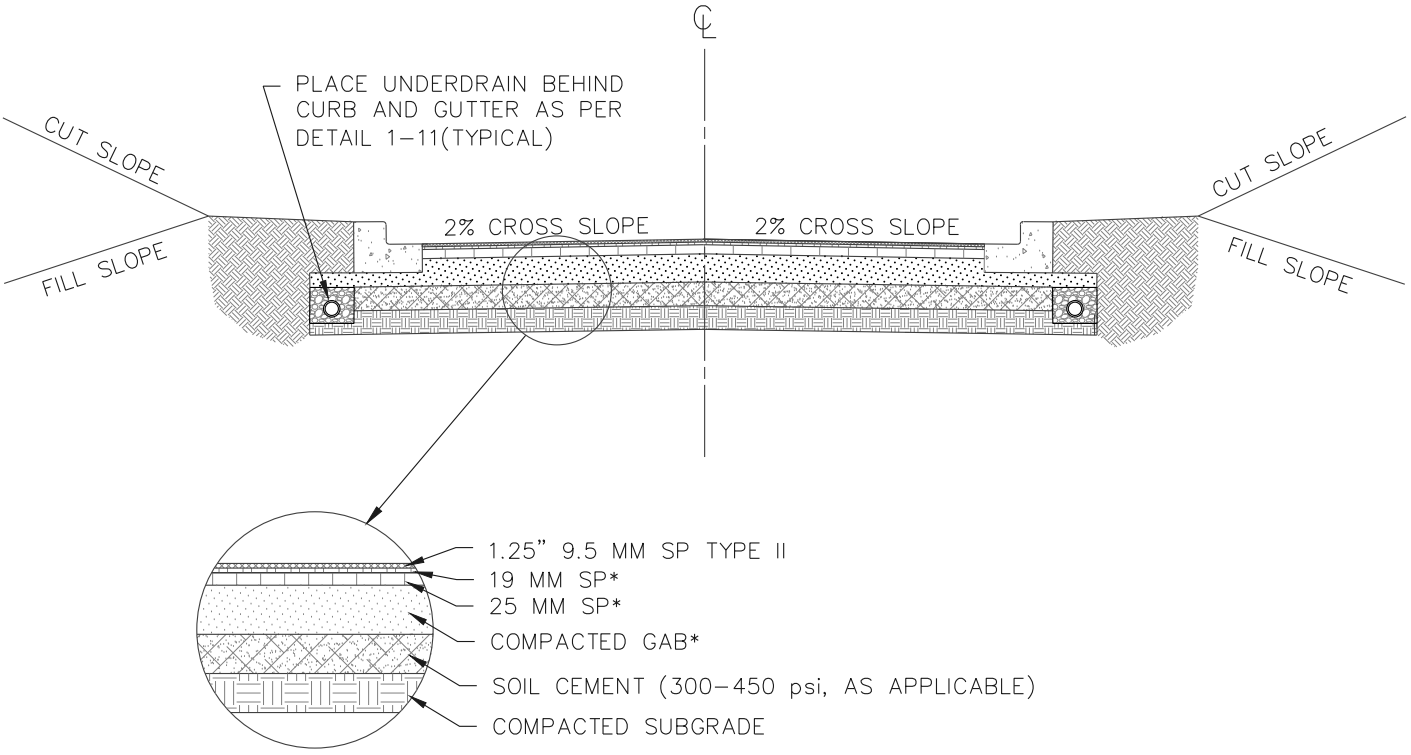
All posts shall be securely anchored in concrete footings, neatly crowned to shed water. Footings shall be poured in cored holes unless the soil will not permit coring, in which case alternate methods will be permitted subject to prior approval by the County Engineer. Footings for line posts shall be 9 inch diameter by 2 feet 9 inch deep and gate posts shall be 12 inch diameter by 3 feet 3 inch deep. In all cases, the posts shall extend to within 3 inches of the bottom of the footing. Posts shall be aligned and set to permit fabric and top rail installation at a uniform grade approximately the general slope of the ground. Where necessary, to prevent short length sags of dips in the top of the fence, post heights shall be adjusted as directed by the County Engineer.

14.3.2 Post Spacing

Each run of fence shall be set up so that a uniform spacing of posts will result. The spacing shall be approximately, but not more than 10 feet. In all runs in excess of 200 feet, and in shorter runs when desired by the contractor, pull posts shall be installed to facilitate proper stretching of the fabric during its installation.

DETAILS

COLUMBIA COUNTY
GEORGIA



*THICKNESSES VARY AND SHALL BE IN ACCORDANCE WITH FINAL APPROVED PAVEMENT DESIGN SUPPLEMENT A FOR RESIDENTIAL SUBDIVISION ROADS. THICKNESSES FOR MAJOR COLLECTOR AND ARTERIAL ROADS SHALL BE BASED ON AASHTO/GDOT DESIGN METHODS, BUT IN NO CASE SHALL BE LESS THAN STD 1–2.1.

ROAD TYPE	R/W WIDTH	MINIMUM PAVEMENT WIDTH
COMMERCIAL	VARIES	VARIES
INDUSTRIAL	80'	VARIES
PRIMARY ARTERIAL	150'	48'
SECONDARY ARTERIAL	120'	48'
URBAN COLLECTOR	80'	32' B/C to B/C
MINOR RURAL ROAD	60'	22' WITH DITCHES
URBAN RESIDENTIAL	50'	32' B/C to B/C
URBAN RESIDENTIAL	50'	28' B/C to B/C

NOTES:

1. MINIMUM R/W AND PAVEMENT WIDTHS SHOWN ABOVE UNLESS OTHERWISE APPROVED BY THE COUNTY ENGINEER.
2. WIDER R/W AND PAVEMENT WIDTHS MAY BE REQUIRED, AS DIRECTED BY THE COUNTY ENGINEER.
3. BOTH FILL AND CUT SLOPES SHALL BE 6:1 MAXIMUM, RESIDENTIAL; 3:1 MAXIMUM, OTHER.

PAVEMENT CROSS SECTION

NOT TO SCALE

Approved By: _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____
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Revision No. _____ Date: _____
Revision No. _____ Date: _____

COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

1–1

ISSUE DATE: 3/3/2022

Approved By: _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____

COLUMBIA COUNTY GEORGIA

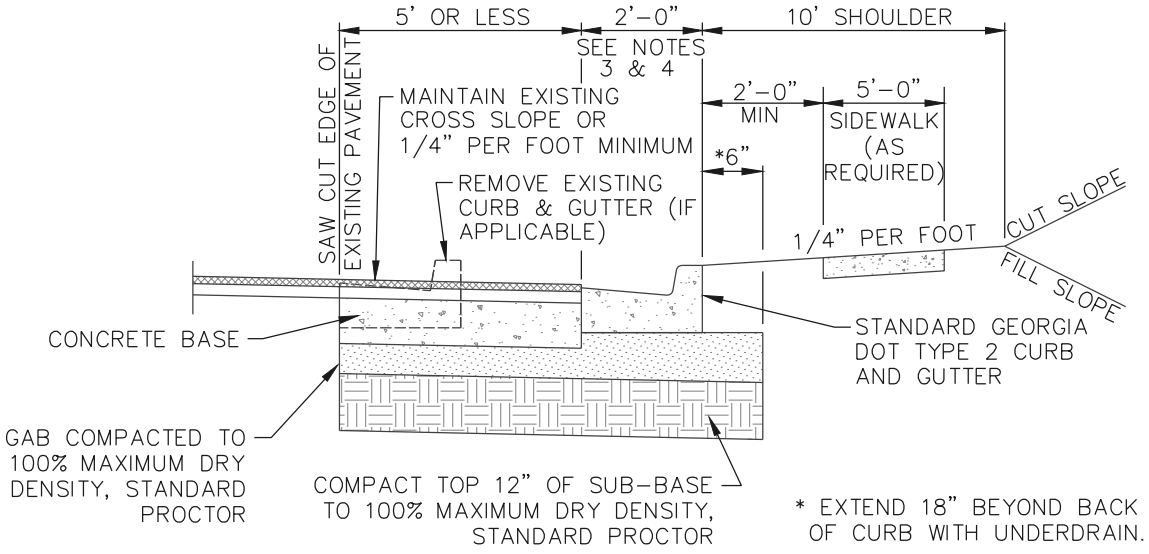
ENGINEERING SERVICES DIVISION

PAVEMENT WIDENING

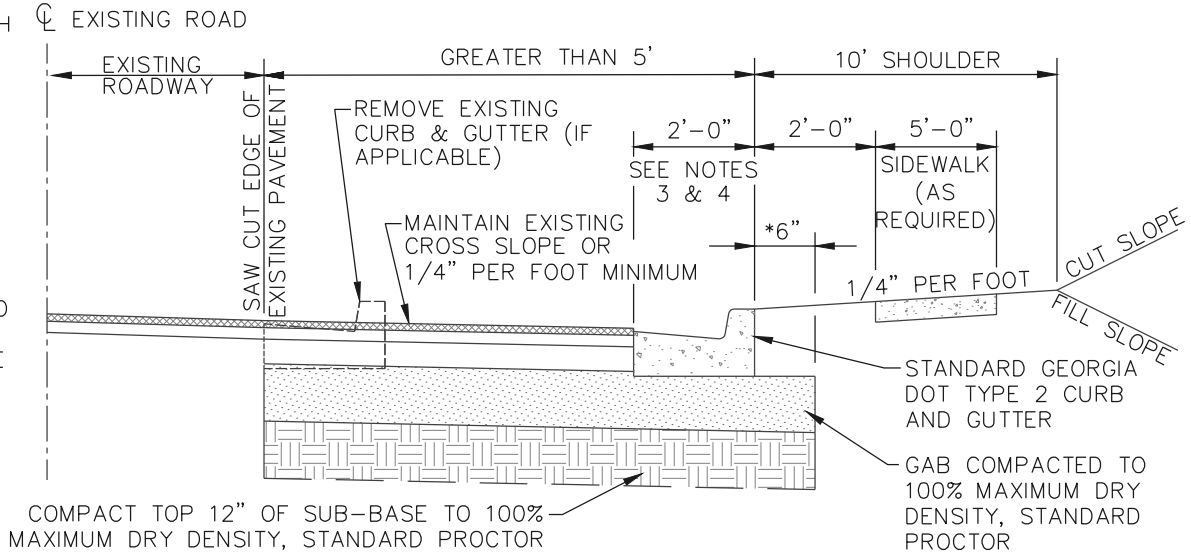
NOT TO SCALE

NOTES:

1. IF A DELAY IN PAVING IS EXPECTED, THE GRADED AGGREGATE BASE MAY BE PRIMED. PRIME COATS SHALL BE APPLIED IN ACCORDANCE WITH THE COLUMBIA COUNTY ENGINEERING DIVISION CONSTRUCTION SPECIFICATION 6.0.
2. A BITUMINOUS TACK COAT SHALL BE APPLIED BETWEEN EACH LIFT OF ASPHALTIC CONCRETE AND ON FACE OF SAW CUT ASPHALT EDGE AND CONCRETE GUTTER IN ACCORDANCE WITH COLUMBIA COUNTY ENGINEERING DIVISION CONSTRUCTION SPECIFICATION 6.0, OR AS DIRECTED BY THE COUNTY ENGINEER.
3. USE 30" CURB AND GUTTER ON MAJOR AND PRINCIPAL ARTERIALS OR MATCH EXISTING.
4. A GEORGIA DOT TYPE III FLUME, HOOD BACK INLET, OR CATCH BASIN IS REQUIRED AT THE END OF THE NEW CURB SECTION IF AN EXISTING DITCH SECTION IS PRESENT IN THE R/W.
5. SEE STANDARD DETAIL 1-2.1 FOR MINIMUM PAVEMENT THICKNESSES.
6. USE OF JOINT FABRIC FOR THE CONCRETE BASE SHALL BE REQUIRED UNLESS OTHERWISE DIRECTED BY THE COUNTY ENGINEER.
7. JOINTS IN CONCRETE BASE TO BE PLACED AT 50 FT INTERVALS, OR AS OTHERWISE DIRECTED BY THE COUNTY ENGINEER.
8. BOTH FILL AND CUT SLOPES SHALL BE 6:1 MAXIMUM, RESIDENTIAL; 3:1 MAXIMUM, OTHER.



TYPICAL WIDENING SECTION (5' WIDE OR LESS)
LOCAL STREETS, MAJOR AND MINOR COLLECTORS, AND ALL ARTERIALS



TYPICAL WIDENING SECTION (GREATER THAN 5' WIDE)

STANDARD DETAIL NUMBER
1 - 2
ISSUE DATE: 3/3/2022

MINIMUM THICKNESS		
MATERIAL	LOCAL/COLLECTOR	ARTERIAL
CLASS B CONCRETE (4,000 psi)	8"	10"
9.5 MM SP OR 12.5 MM SP	3"	3"

5' WIDE OR LESS

MINIMUM THICKNESS		
MATERIAL	LOCAL/COLLECTOR	ARTERIAL
GAB	10"	10"
25 MM SP	3"	4"
19 MM SP	2"	3"
12.5 MM SP	1½"	1½"

GREATER THAN 5' WIDE

NOTE:
BASED ON THE WIDTH OF THE WIDENING, CONTRACTOR SHALL CONSTRUCT PAVEMENT WIDENINGS IN ACCORDANCE WITH THE RESPECTIVE MINIMUM PAVEMENT SECTION THICKNESSES ABOVE OR SHALL MATCH THE EXISTING PAVEMENT SECTION THICKNESSES, WHICHEVER IS GREATER.

PAVEMENT WIDENING CHART

NOT TO SCALE

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Revision No. _____ Date: _____
Revision No. _____ Date: _____
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Revision No. _____ Date: _____
Revision No. _____ Date: _____

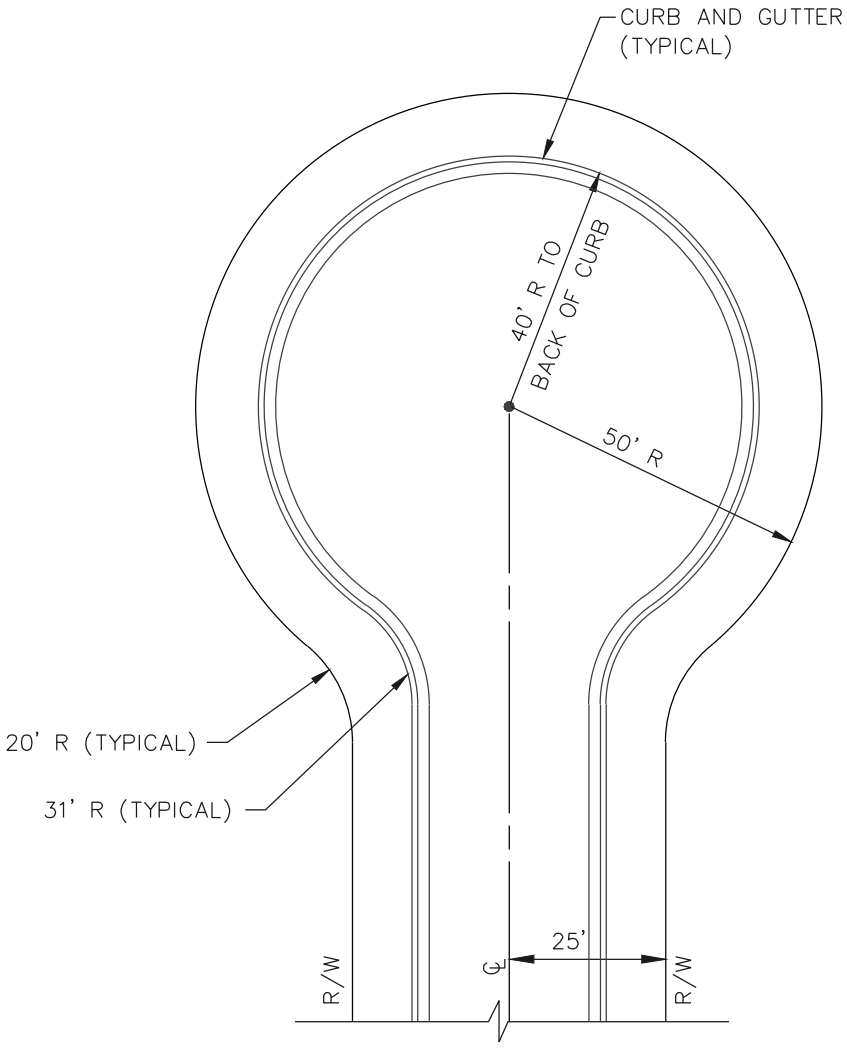
COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

1–2.1

ISSUE DATE: 3/3/2022

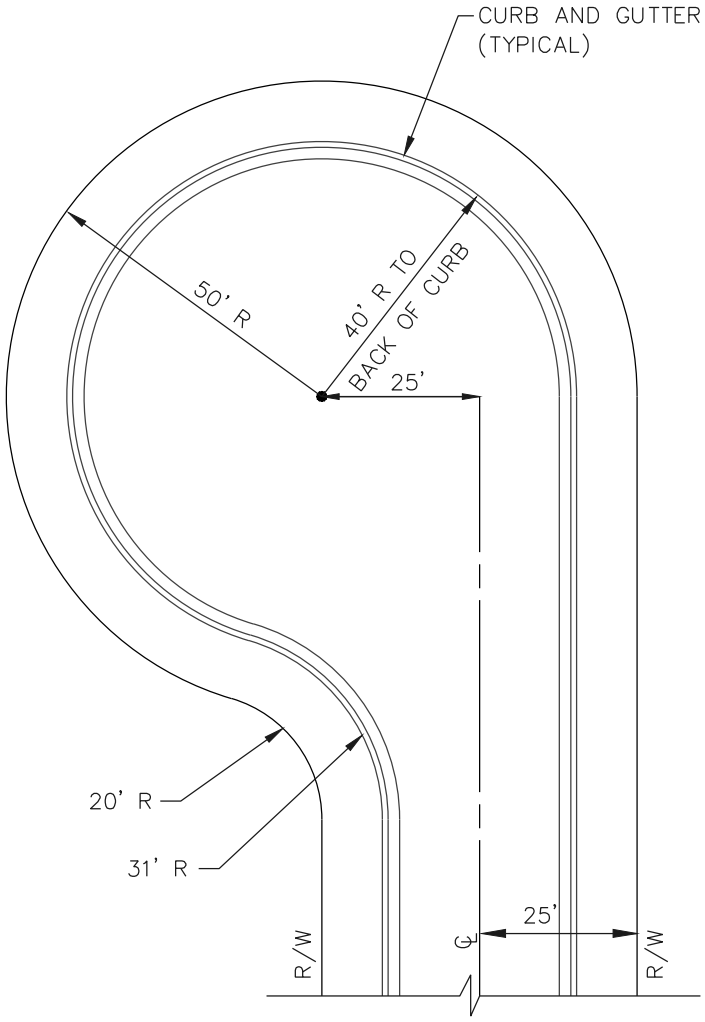


NOTE:
1. RADIUS MEASUREMENTS ARE TO BACK OF CURB UNLESS INDICATED OTHERWISE.

TYPICAL CUL-DE-SAC

NOT TO SCALE

Approved By: _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____	COLUMBIA COUNTY GEORGIA	ENGINEERING SERVICES DIVISION	STANDARD DETAIL NUMBER 1-3 ISSUE DATE: 3/3/2022

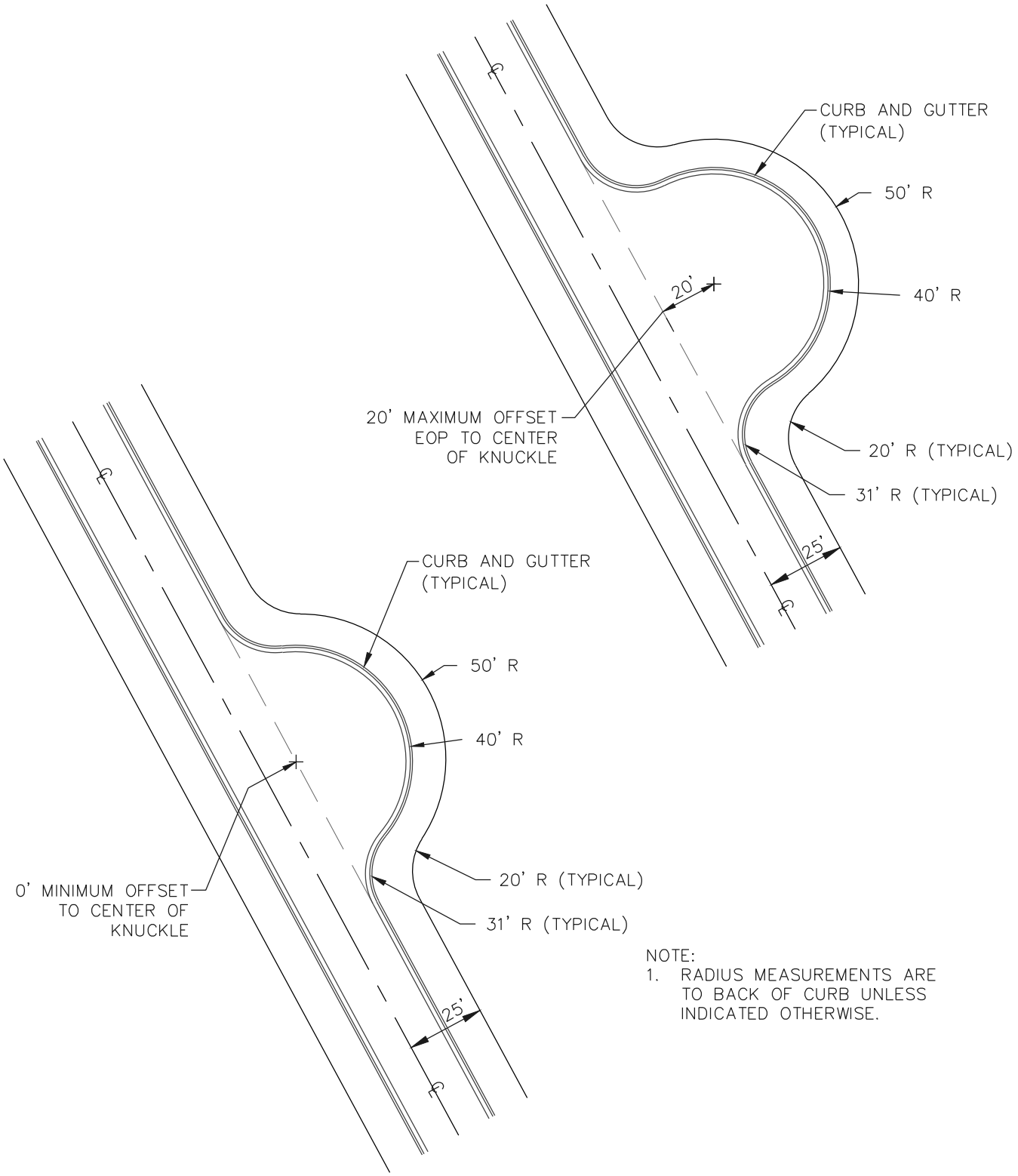


NOTE:
1. RADIUS MEASUREMENTS ARE TO BACK OF CURB UNLESS INDICATED OTHERWISE.

OFFSET CUL-DE-SAC

NOT TO SCALE

Approved By: _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____	COLUMBIA COUNTY GEORGIA	ENGINEERING SERVICES DIVISION	STANDARD DETAIL NUMBER 1 – 4 ISSUE DATE: 3/3/2022

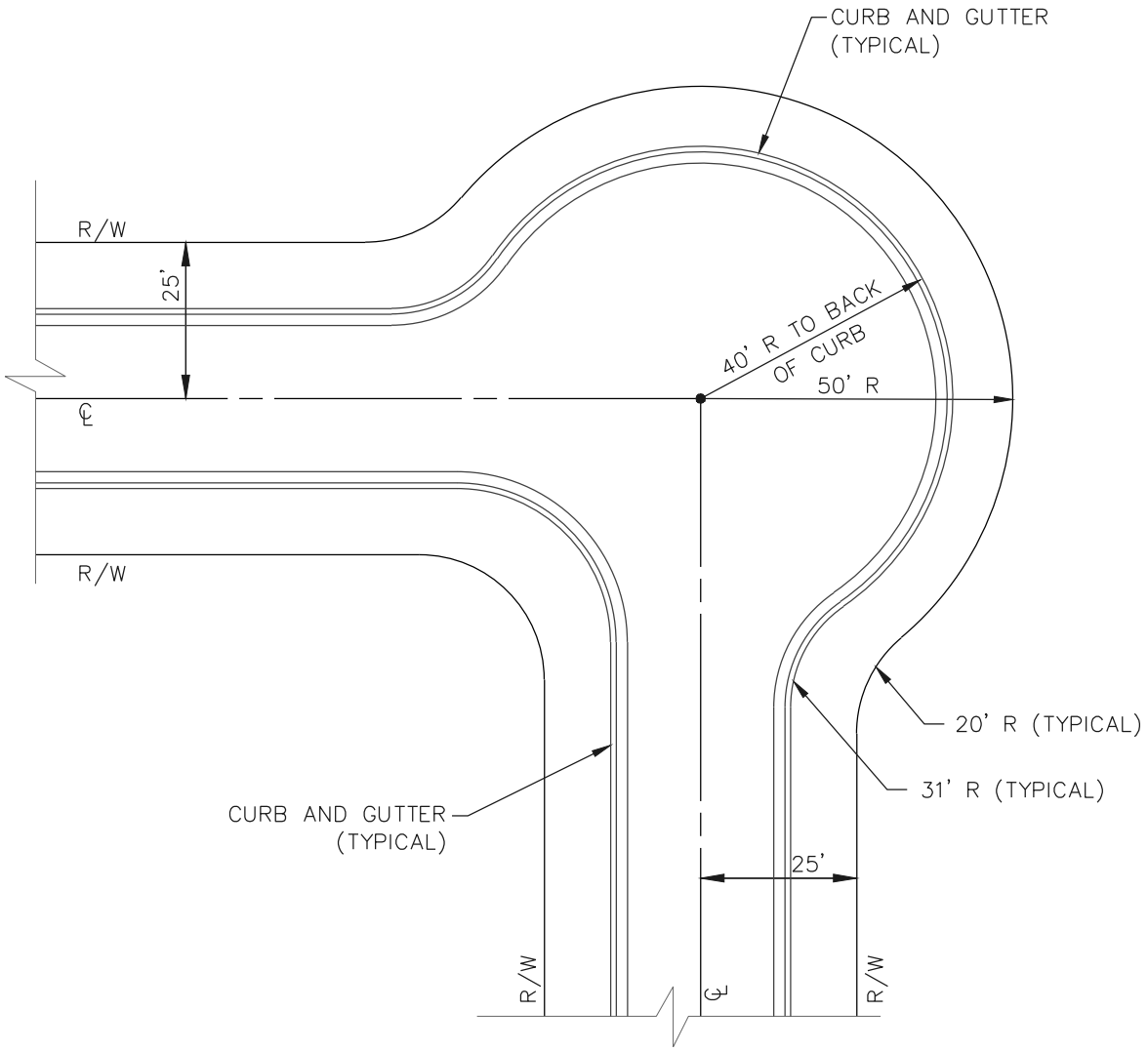


NOTE:
1. RADIUS MEASUREMENTS ARE TO BACK OF CURB UNLESS INDICATED OTHERWISE.

KNUCKLE CUL-DE-SACS

NOT TO SCALE

Approved By: _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____ Revision No. _____ Date: _____	COLUMBIA COUNTY GEORGIA ENGINEERING SERVICES DIVISION	STANDARD DETAIL NUMBER 1-5 ISSUE DATE: 3/3/2022



NOTE:
1. RADIUS MEASUREMENTS ARE TO BACK OF CURB UNLESS INDICATED OTHERWISE.

BUBBLE CUL-DE-SAC

NOT TO SCALE

Approved By: _____	Date: _____	COLUMBIA COUNTY GEORGIA	ENGINEERING SERVICES DIVISION
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Revision No. _____	Date: _____		ISSUE DATE: 3/3/2022
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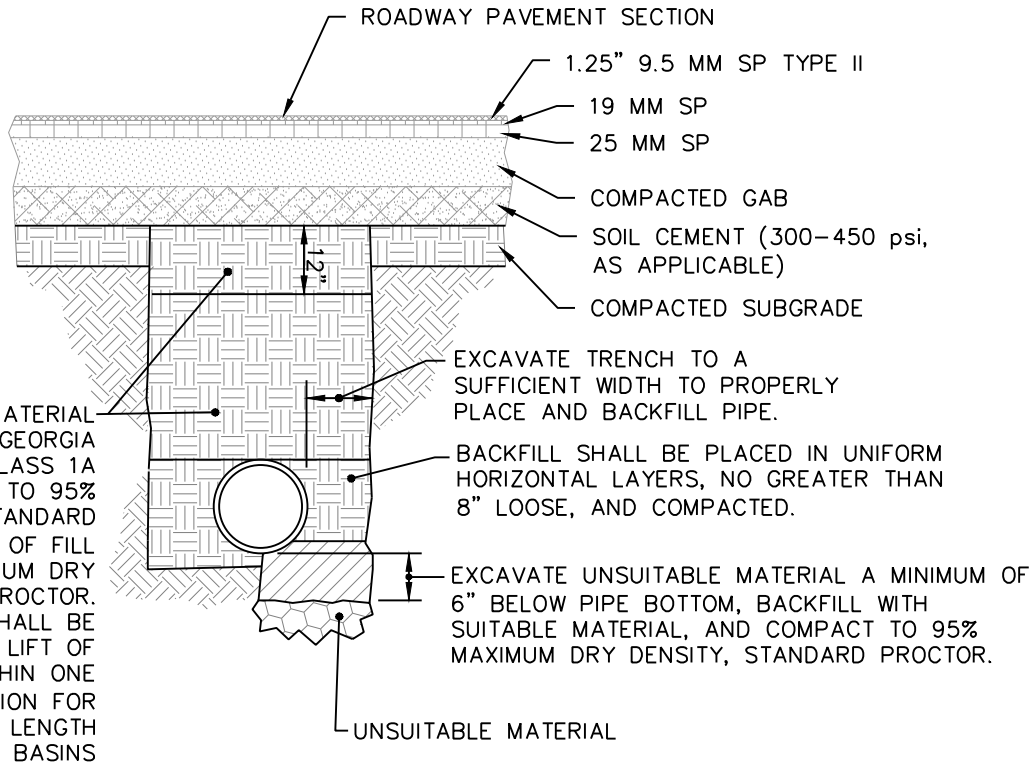

NOTES:

1. ALL COMPACTION DENSITIES SHALL BE IN ACCORDANCE WITH ASTM D698, STANDARD PROCTOR.
2. ALL WORK SHALL BE INSPECTED DURING CONSTRUCTION BY THE COUNTY ENGINEER BEFORE INSTALLING ANY BACKFILL MATERIAL.
3. PAVEMENT SECTION TO BE PLACED AFTER PIPE PLACEMENT AND COMPACTION OF BACKFILL UNLESS ADVANCED NOTIFICATION OTHERWISE IS PROVIDED BY THE COUNTY ENGINEER.
4. CONTRACTOR MAY BACKFILL TRENCHES WITHIN ROADWAY WITH #57 STONE IN THE ABSENCE OF THE COUNTY ENGINEER.

TYPICAL TRENCH EXCAVATION

ROADWAY

NOT TO SCALE

Approved By:		Date:	
Revision No.		Date:	
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Revision No.		Date:	
Revision No.		Date:	
Revision No.		Date:	

COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

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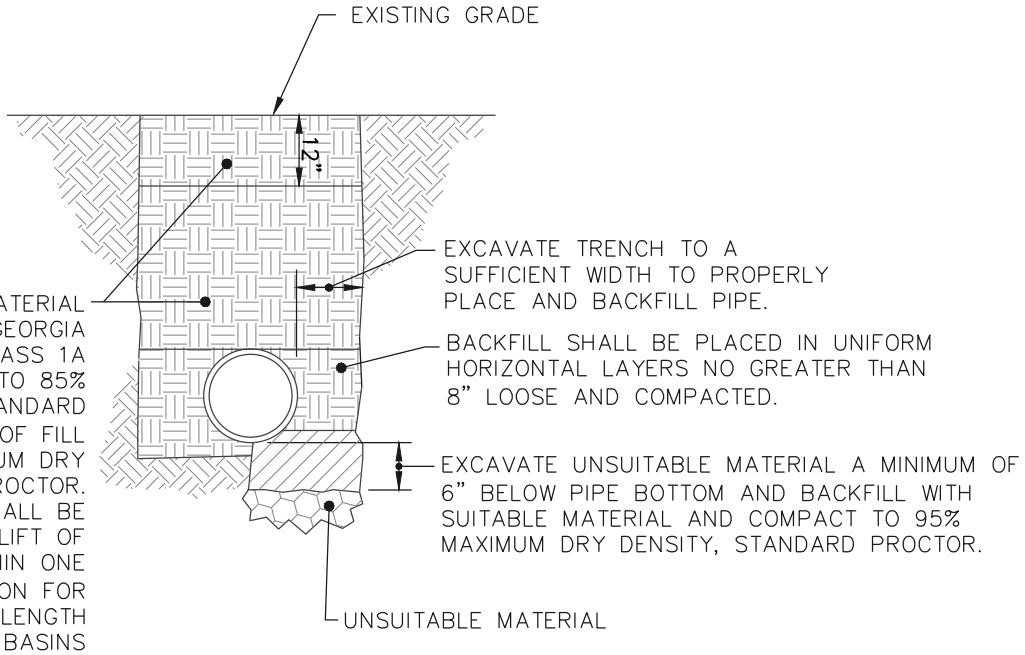
ISSUE DATE: 3/3/2022



BACKFILL WITH SUITABLE MATERIAL CONFORMING TO CURRENT GEORGIA DOT SPECIFICATION 810 FOR CLASS 1A MATERIAL COMPACTED TO 85% MAXIMUM DRY DENSITY, STANDARD PROCTOR, WITH THE TOP 12" OF FILL COMPACTED TO 95% MAXIMUM DRY DENSITY, STANDARD PROCTOR. COMPACTION TESTING SHALL BE PERFORMED ON EVERY OTHER LIFT OF BACKFILL MATERIAL UP TO WITHIN ONE (1) FOOT OF SUBGRADE ELEVATION FOR EACH SECTION OF PIPE. THE LENGTH OF PIPE BETWEEN TWO CATCH BASINS SHALL BE CONSIDERED A SECTION.

NOTES:

1. ALL COMPACTION DENSITIES SHALL BE IN ACCORDANCE WITH ASTM D698, STANDARD PROCTOR.
2. ALL WORK SHALL BE INSPECTED DURING CONSTRUCTION BY THE COUNTY ENGINEER BEFORE INSTALLING ANY BACKFILL MATERIAL UNLESS ADVANCED NOTIFICATION OTHERWISE IS PROVIDED BY THE COUNTY ENGINEER.
3. CONTRACTOR MAY BACKFILL NON-ROADWAY TRENCHES WITH #57 STONE IN THE ABSENCE OF COUNTY ENGINEER.

TYPICAL TRENCH EXCAVATION

NON-ROADWAY

NOT TO SCALE

Approved By: _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____
Revision No. _____ Date: _____

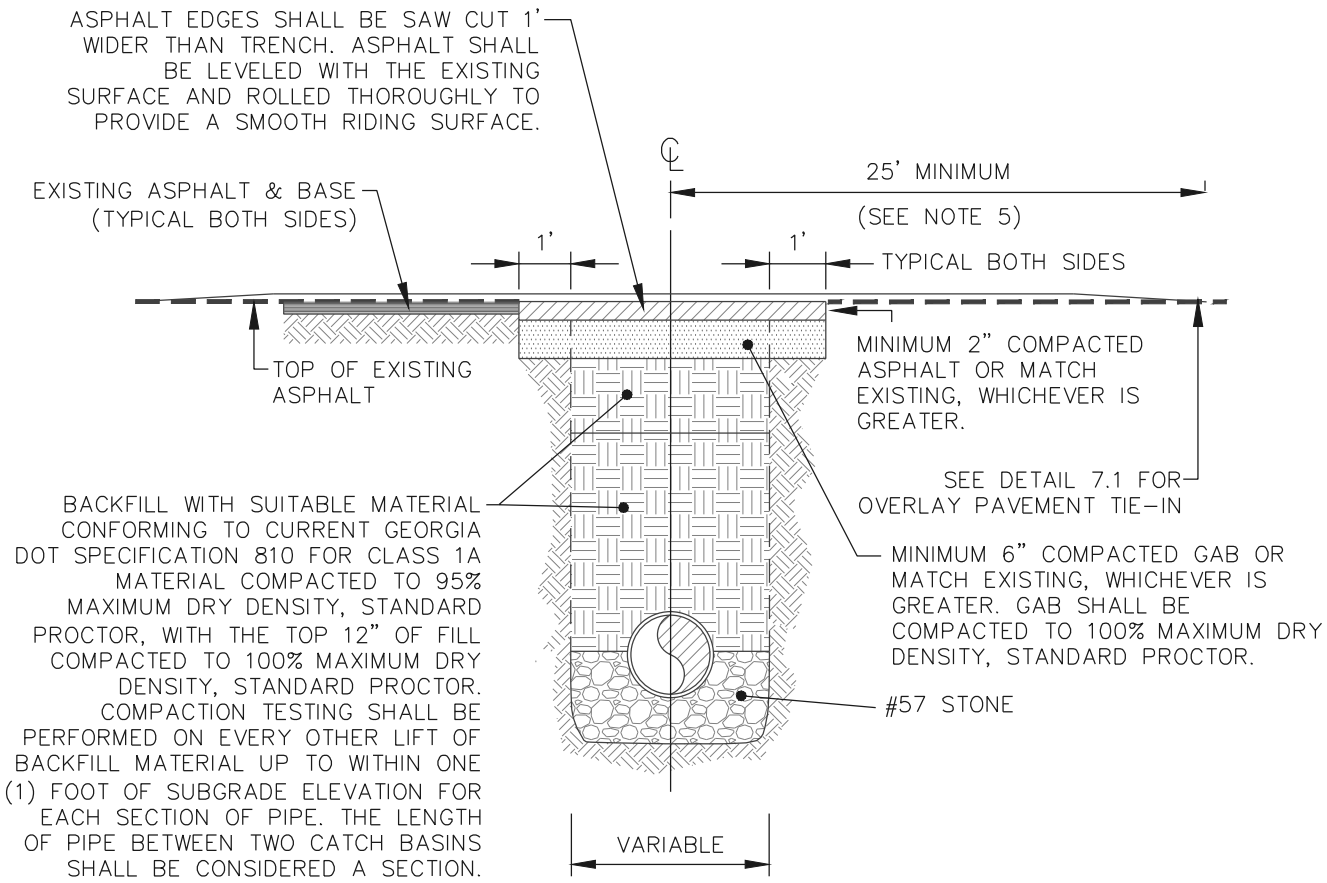
COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

1-8

ISSUE DATE: 3/3/2022



ON LONGITUDINAL CUTS EXCEEDING 150' IN LENGTH, THE ENTIRE WIDTH OF ROADWAY SHALL BE RESURFACED, 25' BEYOND THE CUTS.

NOTES:

1. ALL STREET CUTS SHALL BE COVERED WITH STEEL PLATES OF SUFFICIENT THICKNESS TO SPAN THE CUT WITHOUT NOTICEABLE DEFLECTION. PLATES SHALL REMAIN IN PLACE UNTIL PAVING IS COMPLETED. ANY PAVEMENT MARKINGS AFFECTED BY THE CUT SHALL BE REINSTALLED TO ORIGINAL STATUS.
2. ALL COMPACTION DENSITIES SHALL BE IN ACCORDANCE WITH ASTM D698, STANDARD PROCTOR.
3. ALL WORK SHALL BE INSPECTED DURING CONSTRUCTION BY THE COUNTY ENGINEER BEFORE INSTALLING ANY BACKFILL MATERIAL UNLESS ADVANCED NOTIFICATION OTHERWISE IS PROVIDED BY THE COUNTY ENGINEER.
4. CONTRACTOR MAY BACKFILL TRENCHES WITHIN ROADWAY WITH #57 STONE IN THE ABSENCE OF THE COUNTY ENGINEER.
5. USE A MINIMUM OVERLAY OF 1.25" 9.5 MM SP TYPE II, OR AS DIRECTED BY THE COUNTY ENGINEER.

PAVEMENT CUT REPAIR

METHOD #1 (PREFERRED)

NOT TO SCALE

Approved By: _____	Date: _____		
Revision No. _____	Date: _____		
Revision No. _____	Date: _____		
Revision No. _____	Date: _____		
Revision No. _____	Date: _____		
Revision No. _____	Date: _____		

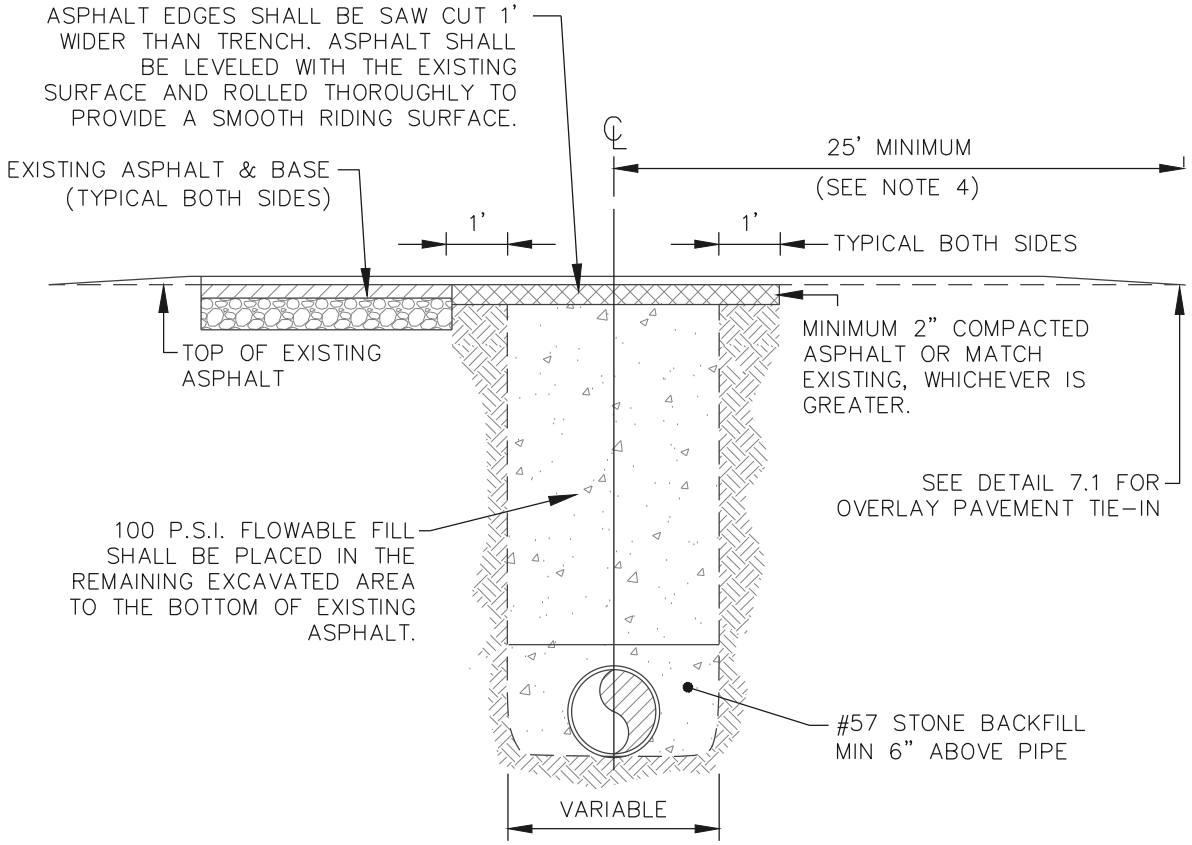
COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

1 – 9

ISSUE DATE: 3/3/2022



NOTES:

1. THIS PAVEMENT CUT REPAIR METHOD IS NOT PERMITTED FOR USE WITH WATER AND SANITARY SEWER PIPE OR WHEN IN CONFLICT WITH WATER OR SANITARY SEWER PIPE.
2. ALL STREET CUTS SHALL BE COVERED WITH STEEL PLATES OF SUFFICIENT THICKNESS TO SPAN THE CUT WITHOUT NOTICEABLE DEFLECTION. PLATES SHALL REMAIN IN PLACE UNTIL PAVING IS COMPLETED. ANY PAVEMENT MARKINGS AFFECTED BY THE CUT SHALL BE REINSTALLED TO ORIGINAL STATUS.
3. ALL WORK SHALL BE INSPECTED DURING CONSTRUCTION BY THE COUNTY ENGINEER BEFORE INSTALLING ANY BACKFILL MATERIAL.
4. USE A MINIMUM OVERLAY OF 1.25" 9.5 MM SP TYPE II, OR AS DIRECTED BY THE COUNTY ENGINEER.

PAVEMENT CUT REPAIR

METHOD #2

NOT TO SCALE

Approved By:		Date:	
Revision No.		Date:	
Revision No.		Date:	
Revision No.		Date:	
Revision No.		Date:	
Revision No.		Date:	

COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

1-10

ISSUE DATE: 3/3/2022

NOTES

1. UNDERDRAIN BEHIND CURB SHALL BE USED IN ALL CUT SECTIONS 3 FEET OR GREATER, WHERE SUBSURFACE WATER IS PRESENT, AND IN IRRIGATED ISLANDS, MEDIANS, AND ENTRANCES IN PUBLIC R/W, OR AS DIRECTED BY COUNTY ENGINEER.
2. A LINE ITEM SHOULD BE INCLUDED WITHIN THE CONTRACT DOCUMENT WHETHER UNDERDRAIN BEHIND CURB IS ANTICIPATED OR NOT.
3. UNDERDRAIN SHALL CONNECT TO STORM STRUCTURES WITH A MAXIMUM DISTANCE BETWEEN OUTLETS AT 500' WHERE CONDITIONS PERMIT.
4. LATERAL PIPE UNDER PAVEMENT SHALL BE SCHEDULE 40 OR HEAVIER, 4"SOLID PIPE WITH SUITABLE STANDARD FITTINGS (ELBOWS, WYES, OR TEES). MUST HAVE A MINIMUM OF 12" COVER.
5. PERFORATED UNDERDRAIN PIPE SHALL BE INSTALLED COMPLETE PRIOR TO PLACING PERVIOUS BASE OR DRAINAGE COURSE.
6. MINIMUM GRADIENT FOR UNDERDRAIN PIPE SHALL BE 0.50%.
7. MINIMUM GRADIENT FOR LATERAL PIPE SHALL BE 1.00%.
8. IRRIGATION IS PROHIBITED IN ISLANDS AND MEDIANS UNLESS UNDERDRAIN AND LATERAL PIPING IS INSTALLED DURING THE CONSTRUCTION OF THE STREETS. AN ENCROACHMENT AND MAINTENANCE AGREEMENT BETWEEN COUNTY AND DEVELOPER IS REQUIRED PRIOR TO APPROVAL OF FINAL PLAT TO ALLOW PRIVATE IRRIGATION IN PUBLIC ISLANDS, MEDIANS AND RIGHT-OF-WAY. PLACEMENT OF IRRIGATION CONDUIT IS RECOMMENDED CONCURRENT TO INSTALLATION OF UNDERDRAIN SYSTEMS.

UNDERDRAIN BEHIND CURB AND GUTTER

NOT TO SCALE

Approved By: _____ Date: _____
Revision No. _____ Date: _____
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COLUMBIA COUNTY
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ENGINEERING
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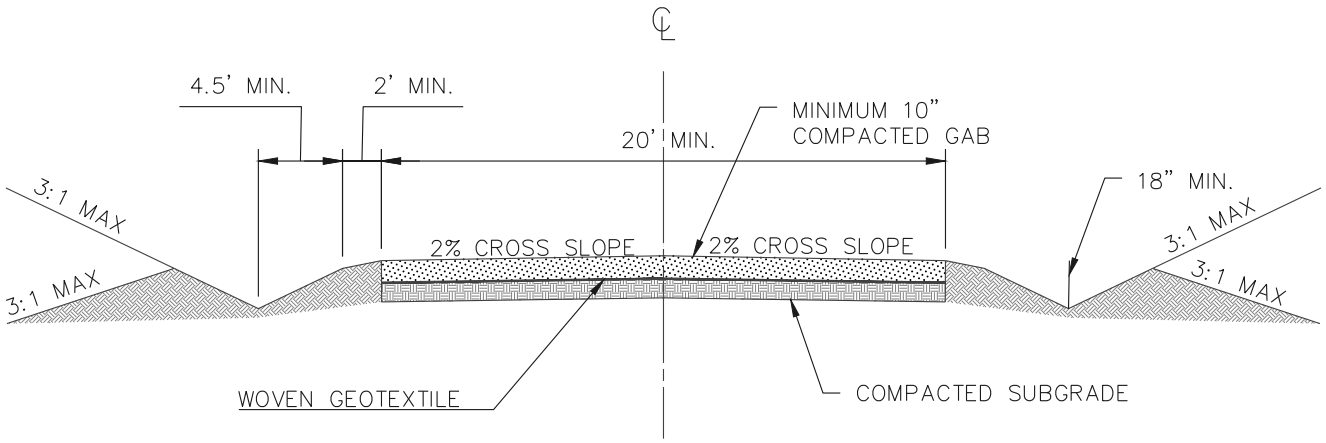
STANDARD DETAIL
NUMBER
1—11

ISSUE DATE: 3/3/2022



NOTES:

1. MAXIMUM ROAD GRADE IS 3% FOR GAB TOPPING WITHOUT WRITTEN APPROVAL.
2. MAXIMUM ROAD GRADE IS 10% IF TOPPED WITH ASPHALT OR CONCRETE.
3. SUBGRADE AND GAB SHALL BE COMPACTED TO 95% STANDARD PROCTOR.
4. ASPHALT TOPPING SHALL ABE 2" 19MM AND 1.25" 12MM OR 9.5MM.
5. CONCRETE TOPPING SHALL BE MINIMUM 6" DEPTH, 3,000 PSI, AND FIBER REINFORCED. CONTROLS JOINTS SHALL BE TOOLED OR SAWED IN ALONG THE CENTER LINE AND EVERY 10' LONGITUDINALLY. EXPANSION JOINTS SHALL BE EVERY 50' AND AT ALL RIGID CONNECTIONS.
6. MAINTENANCE AND INSPECTION AGREEMENT MUST BE ACCEPTED BY THE FIRE MARSHAL AND FIRE CHIEF PRIOR TO ACCEPTANCE.
7. SURFACE MATERIAL, ROAD WIDTH, AND OTHER REQUIREMENTS ARE SUBJECT TO APPROVAL BY THE FIRE MARSHAL AND FIRE CHIEF.
8. DEVIATIONS FROM THIS PLAN MUST BE APPROVED IN WRITING BY THE COUNTY ENGINEER.

EMERGENCY ACCESS ROAD TYPICAL SECTION

NOT TO SCALE

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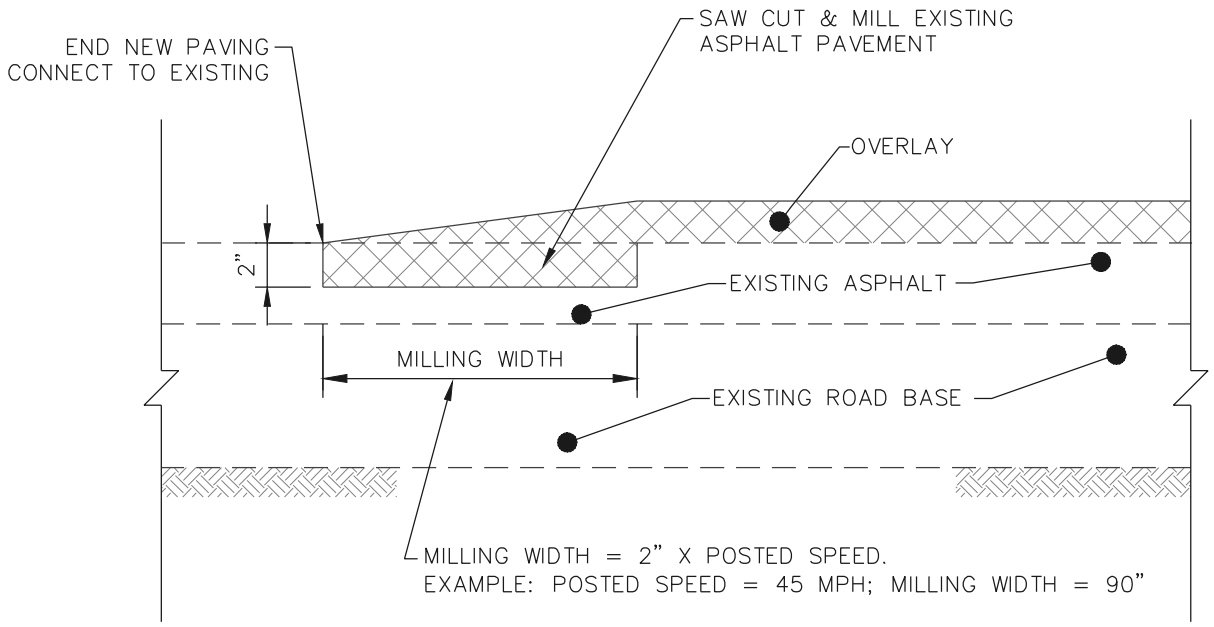
COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

1–12

ISSUE DATE: 3/3/2022



OVERLAY PAVEMENT TIE–IN

NOT TO SCALE

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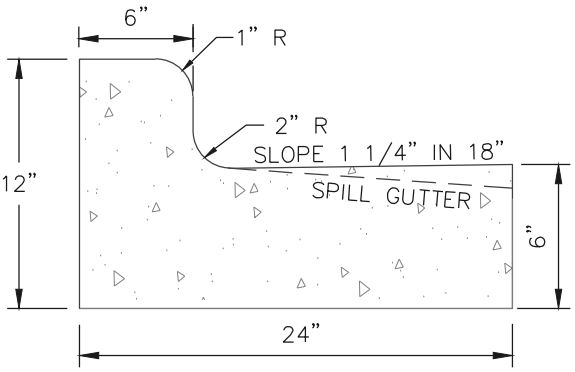
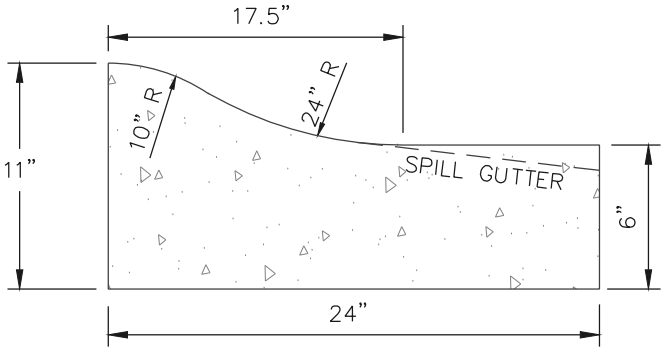
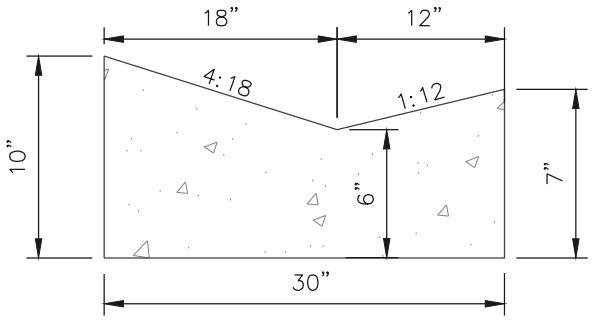


STANDARD CURB AND GUTTER



ROLLED CURB AND GUTTER



VALLEY CURB

NOTES:

1. CONCRETE SHALL HAVE A MINIMUM STRENGTH OF 3000 psi.
2. CONTRACTION JOINTS SHALL BE PLACED SO THAT SECTIONS OF CURB AND GUTTER ARE NOT LESS THAN 5 FEET NOR MORE THAN 10 FEET IN LENGTH.
3. CONTRACTION JOINTS SHALL BE UNIFORMLY PLACED AND SHALL ALIGN WITH CORRESPONDING JOINTS IN SIDEWALK, WHERE ADJOINING.
4. EXPANSION JOINTS SHALL BE PLACED AT INTERVALS NOT TO EXCEED 50 FEET, RADIUS RETURNS, COLD JOINTS, AND ALL RIDGED CONNECTIONS.
5. CURB AND GUTTER SHALL TRANSITION TO A SPILL GUTTER UNIFORMLY WHILE FOLLOWING THE RATE OF SUPER ELEVATION WHERE APPLICABLE.
6. VERTICAL CURB OR HEADER CURB NOT ALLOWED IN COUNTY RIGHT-OF-WAY WITHOUT WRITTEN APPROVAL FROM COUNTY ENGINEER.

CONCRETE CURB AND GUTTER

NOT TO SCALE

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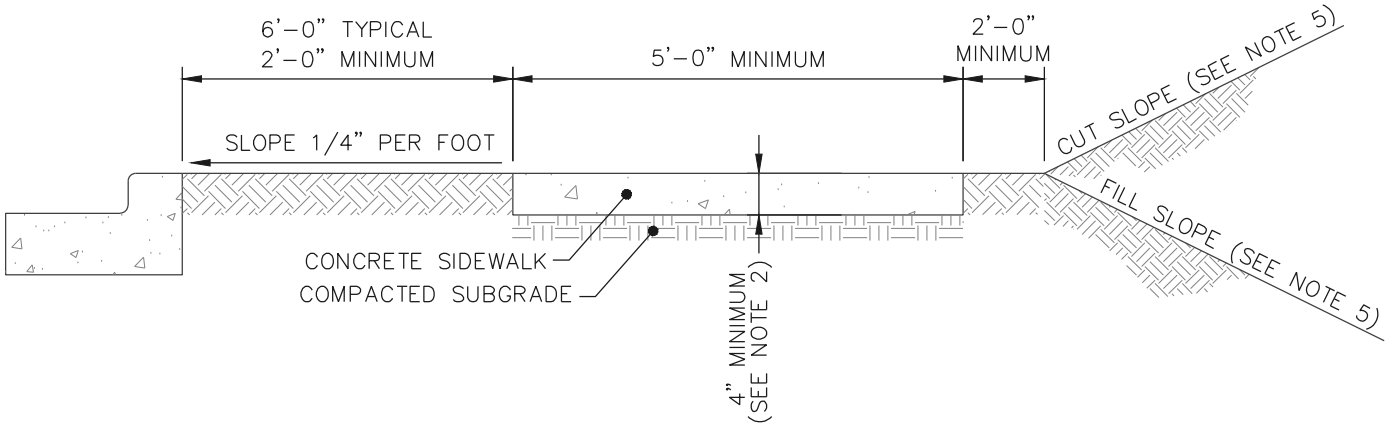
COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

9-1

ISSUE DATE: 3/3/2022



NOTES:

1. CONCRETE SHALL HAVE A MINIMUM STRENGTH OF 3000 psi.
2. SIDEWALKS SHALL BE A MINIMUM OF 6" THICK WHERE CONNECTED THROUGH A DRIVEWAY.
3. CONTRACTION JOINTS SHALL BE PLACED SO THAT SECTIONS OF SIDEWALK ARE NOT LESS THAN 5 FEET IN LENGTH.
4. EXPANSION JOINTS SHALL BE PLACED AT INTERVALS NOT TO EXCEED 50 FEET, RADIUS RETURNS, COLD JOINTS, AND ALL RIDGED CONNECTIONS.
5. BOTH FILL AND CUT SLOPES SHALL BE 6:1 MAXIMUM, RESIDENTIAL; 3:1 MAXIMUM, OTHER.

CONCRETE SIDEWALK

NOT TO SCALE

Approved By: _____	Date: _____
Revision No. _____	Date: _____
Revision No. _____	Date: _____
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Revision No. _____	Date: _____
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COLUMBIA COUNTY
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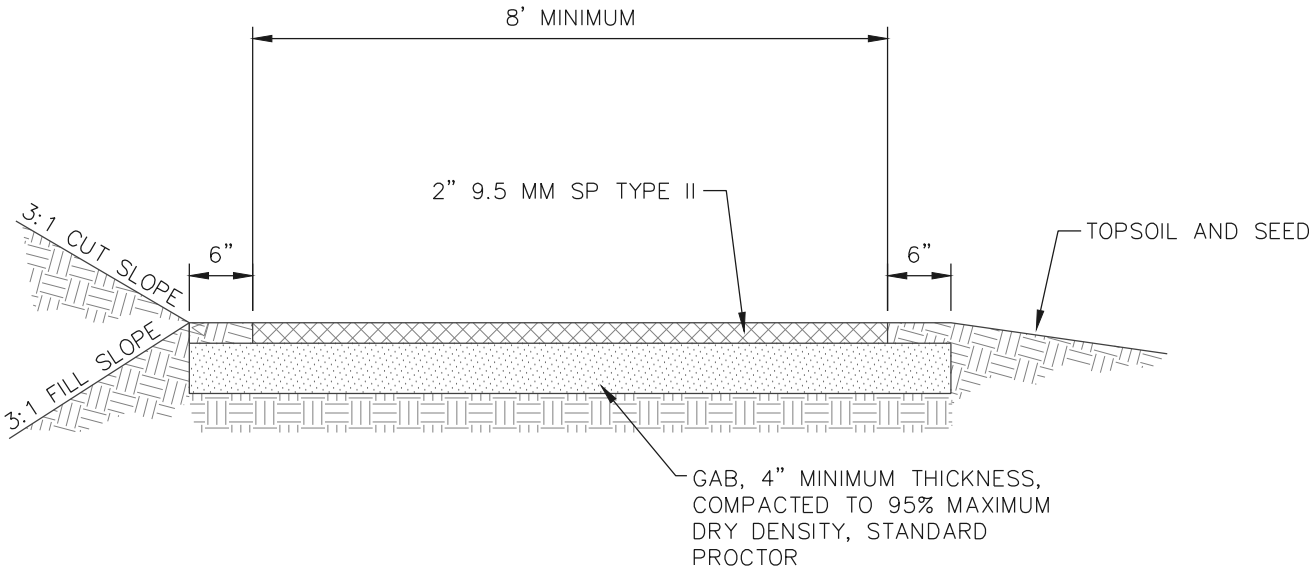
10–1

ISSUE DATE: 3/3/2022



NOTES:

1. BOTH FILL AND CUT SLOPES SHALL BE 6:1 MAXIMUM, RESIDENTIAL; 3:1 MAXIMUM, OTHER.

BITUMINOUS SHARED USE PATH

NOT TO SCALE

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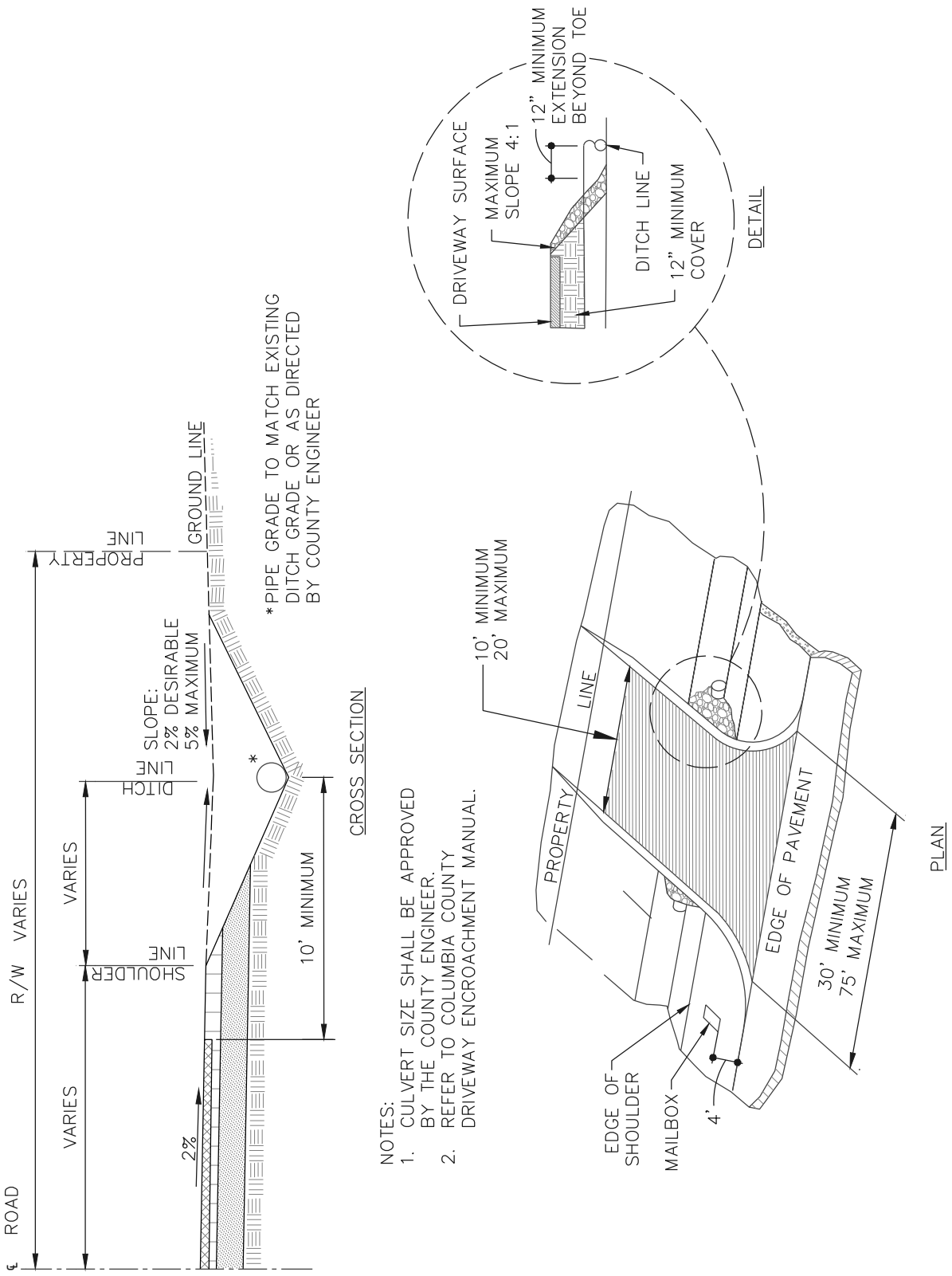

NOTES:
1. CULVERT SIZE SHALL BE APPROVED BY THE COUNTY ENGINEER.
2. REFER TO COLUMBIA COUNTY DRIVEWAY ENCROACHMENT MANUAL.

PRIVATE DRIVEWAY CULVERT

NOT TO SCALE

Approved By: _____ Date: _____
Revision No. _____ Date: _____
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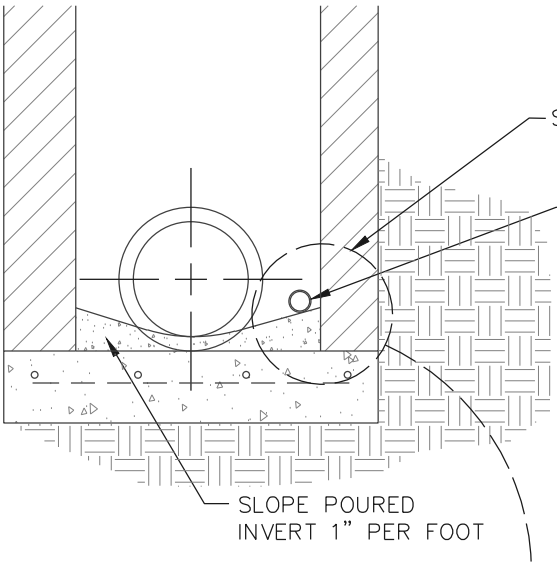
COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

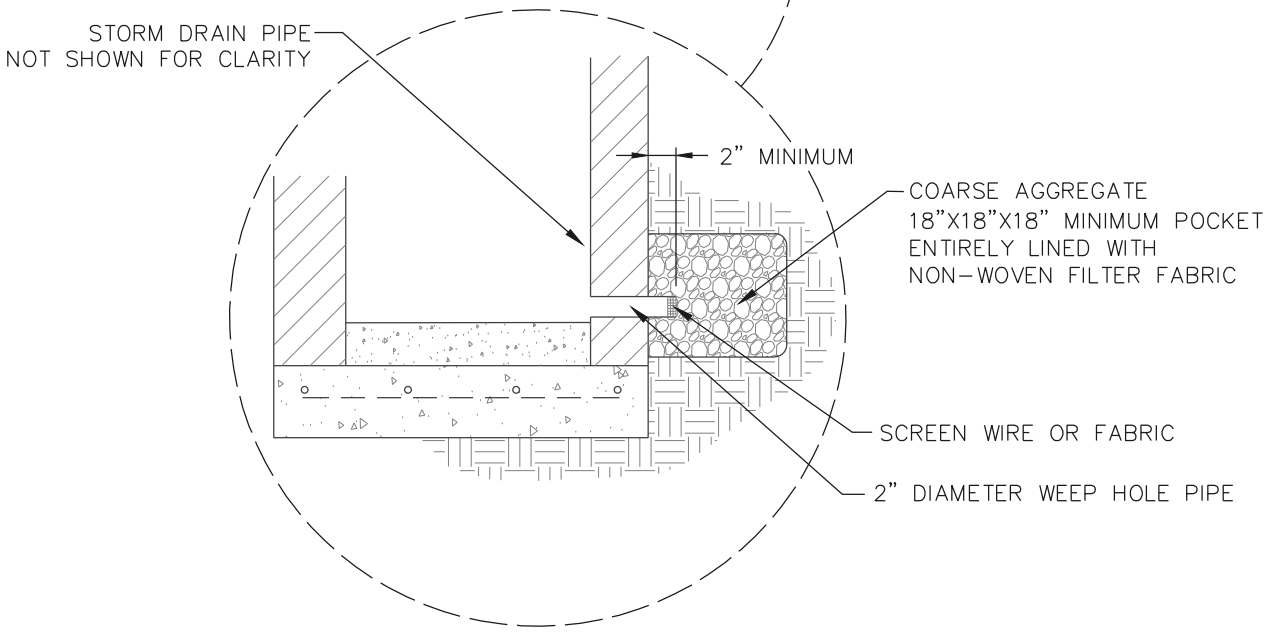
STANDARD DETAIL NUMBER

16–1

ISSUE DATE: 3/3/2022



SECTION DETAIL



INSET DETAIL

NOTE:

1. PLACE ONE (1) 2" DIAMETER WEEP HOLE PIPE IN ALL CATCH BASIN WALLS THAT CONTAIN AN INLET PIPE. THE INVERT OF THE WEEP HOLE PIPE SHALL BE FLUSH WITH THE POURED INVERT ON THE FLOOR OF THE CATCH BASIN OR AS DIRECTED BY THE COUNTY ENGINEER.

WEEP HOLES

NOT TO SCALE

Approved By: _____	Date: _____		
Revision No. _____	Date: _____		
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COLUMBIA COUNTY
GEORGIA

ENGINEERING
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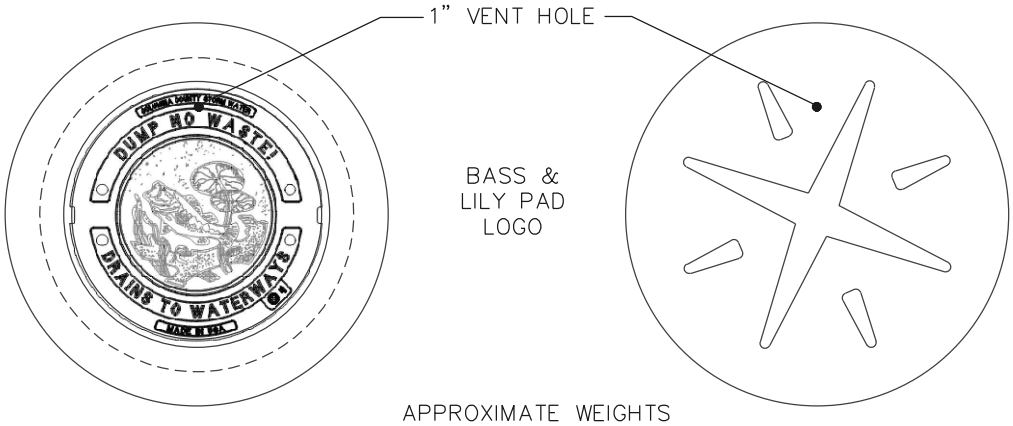
STANDARD DETAIL
NUMBER
16-2

ISSUE DATE: 3/3/2022



APPROXIMATE WEIGHTS

FRAME	90 LBS.
COVER	65 LBS. MIN.
TOTAL	155 LBS. MIN.

COVER FRAME

NOTES:

1. THE COVERS SHALL BE SUCH AS THOSE MANUFACTURED BY:
   - EAST JORDAN IRON WORKS MODEL V-1860-1(COVER) & G1860 (FRAME)
   - U.S. FOUNDRY MODEL 1259-LU
   - OR APPROVED EQUAL
2. CASTING DETAILS:
   - LOGO SHALL BE THE BASS AND LILY PAD
   - LETTERING ON THE TOP SHALL READ:
     "DUMP NO WASTE" (MINIMUM HEIGHT 1")
     "DRAINS TO WATERWAYS" (MINIMUM HEIGHT 1")
     "COLUMBIA COUNTY STORM WATER" (MINIMUM HEIGHT $\frac{1}{2}$")
     "MADE IN USA" (MINIMUM HEIGHT $\frac{1}{2}$")
     THE UNDER SIDE SHALL HAVE CAST INTO IT, THE DATE OF PRODUCTION, HEAT NUMBER, AND MANUFACTURER'S MARK OR SYMBOL.
3. THE COVER SHALL HAVE 1 (ONE) INCH DIAMETER VENT HOLES.
4. THE WEIGHT OF THE COVER SHALL BE MINIMUM 65 LBS.
5. MATERIAL USED IN THE CASTING SHALL BE ASTM A48 CLASS 35B.
6. THE LOAD RATING SHALL BE NON-TRAFFIC OR LIGHT DUTY. THESE COVERS SHALL BE USED IN NON-TRAFFIC AREAS ONLY.
7. ANY COVERS USED IN TRAFFIC AREAS SHALL BE TRAFFIC RATED.

STORM MANHOLE FRAME AND COVER

NON-TRAFFIC RATED

NOT TO SCALE

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COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

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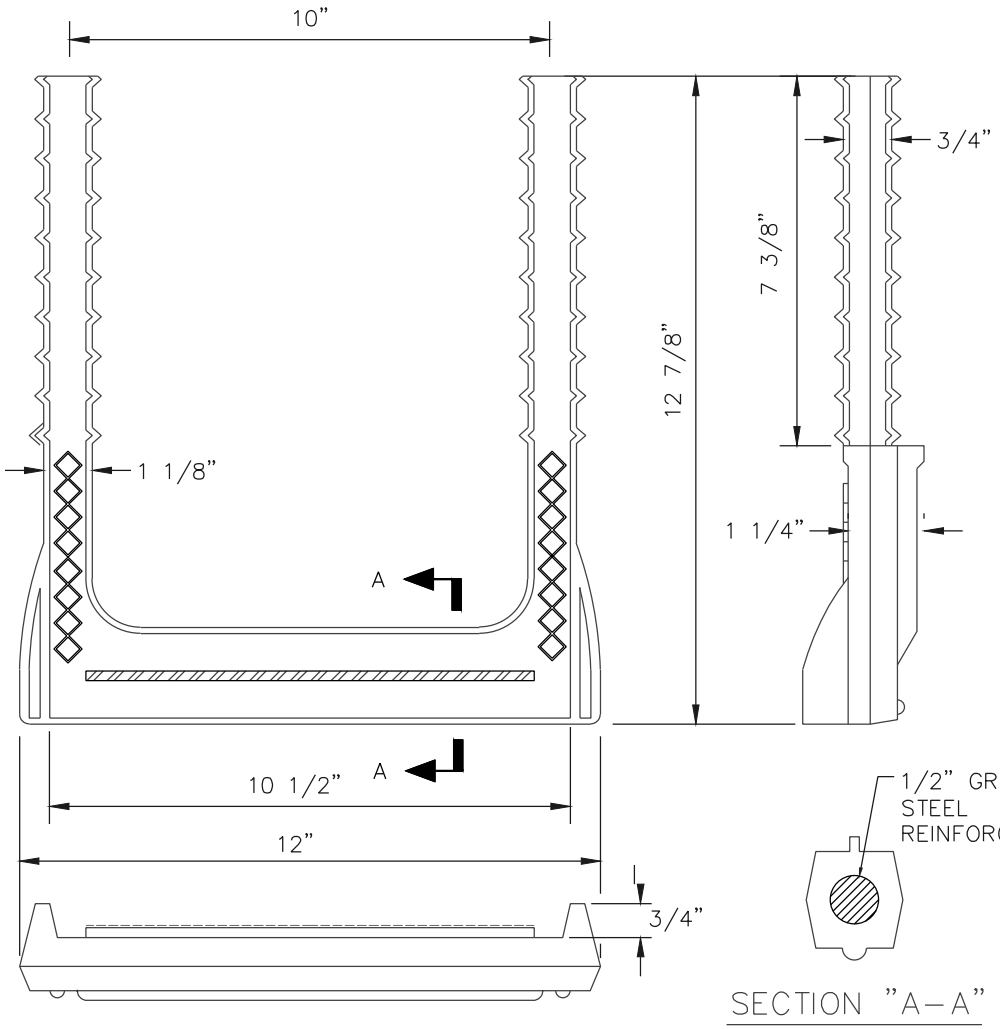
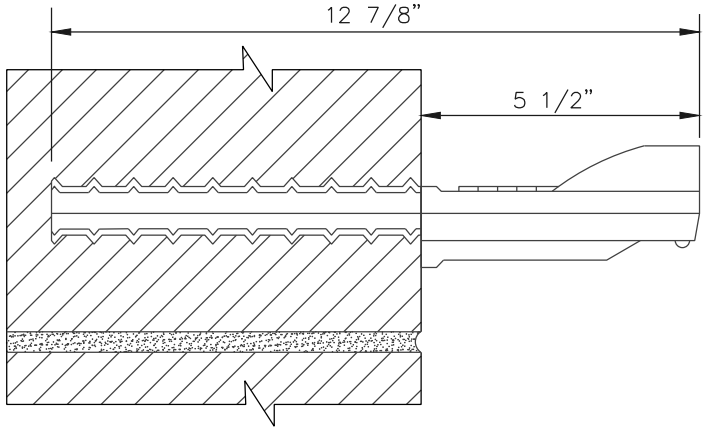
16-3

ISSUE DATE: 1/13/2022





NOTES:
1. STEPS SHALL MEET REQUIREMENTS OF ASTM C-478, ASTM D-4101,ASTM A-615 & ASTHTO M-199.
2. TO BE USED IN BRICK OR CAST-IN-PLACE UNITS.

CATCH BASIN STEP

NOT TO SCALE

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Revision No.		Date:	
Revision No.		Date:	
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COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

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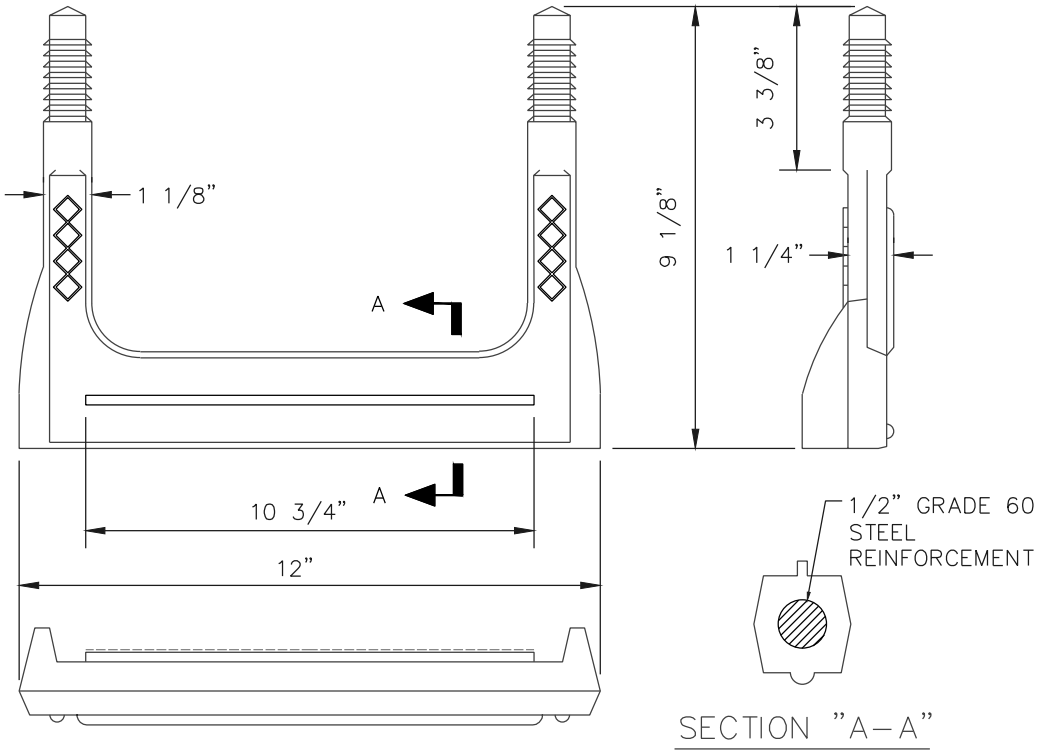

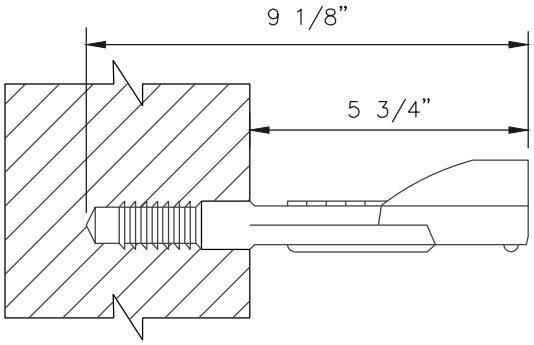

NOTES:
1. STEPS SHALL MEET REQUIREMENTS OF ASTM C-478, ASTM D-4101,ASTM A-615 & ASTHTO M-199.
2. TO BE USED IN PRECAST UNITS ONLY.

PRECAST CATCH BASIN STEP

NOT TO SCALE

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16-4.1

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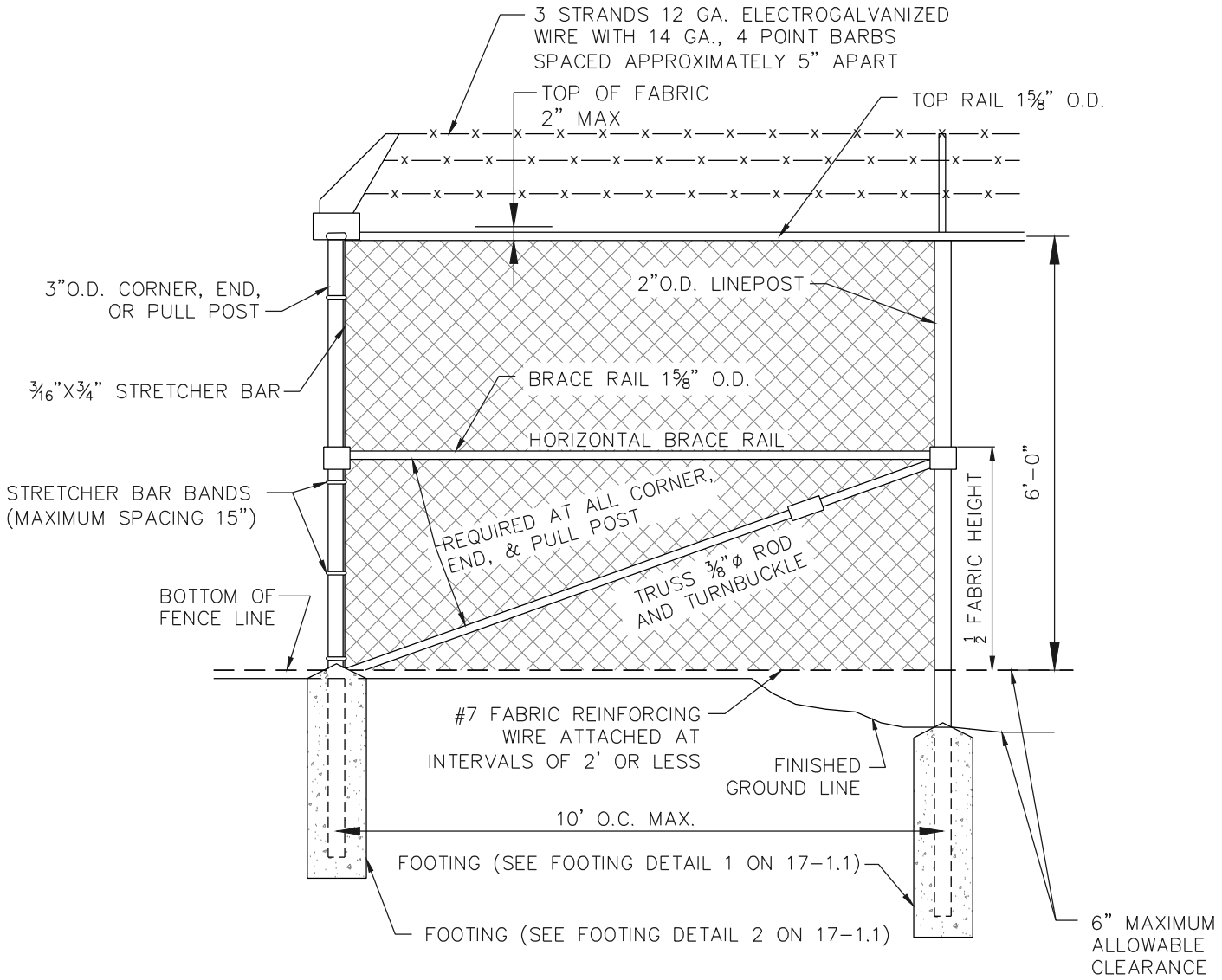

CHAIN-LINK WIRE FENCE

(OVER 4FT HEIGHT)

NOTES:

1. FABRIC SHALL BE FASTENED TO LINE POST AND TOP RAIL POST AT INTERVALS NOT GREATER THAN 15".
2. FABRIC REINFORCING WIRE SHALL BE TIED TO FABRIC WITH GALVANIZED TIES OR CLIPS AT 2' O.C. MAXIMUM SPACING.
3. HORIZONTAL BRACE RAILS AND TRUSS BRACING SHALL BE REQUIRED AT ALL CORNER, END, AND PULL POSTS.
4. FABRIC SHALL BE 9 GA. 2" MESH, CLASS I, GALVANIZED IN CONFORMANCE WITH ASTM A392-63.

STORMWATER MANAGEMENT FACILITY FENCING

NOT TO SCALE

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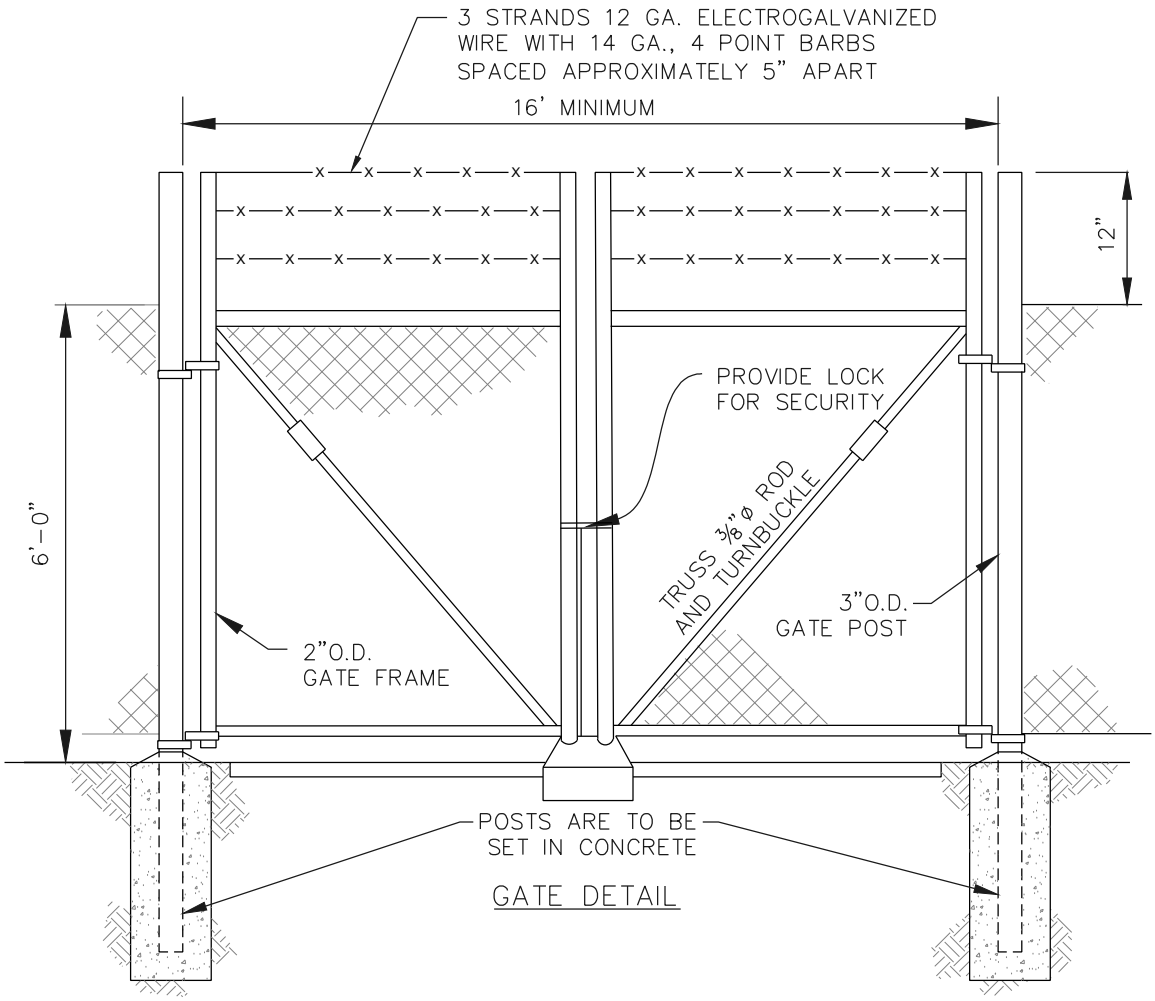
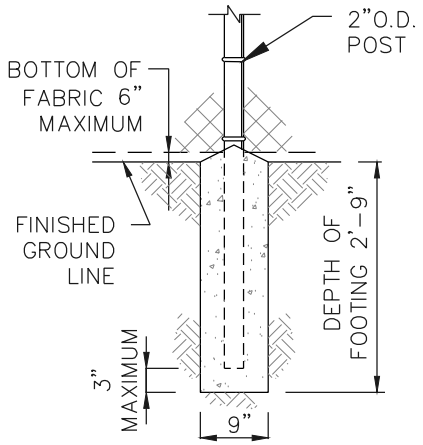
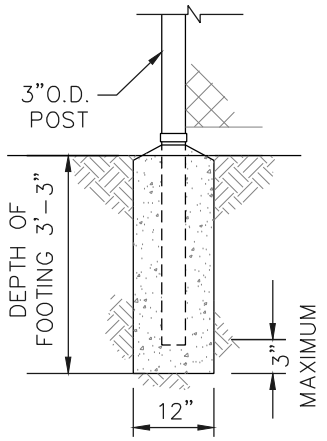


GATE DETAIL



FOOTING DETAIL 1

ALL LINE POSTS SHALL HAVE CONCRETE FOOTINGS AS SHOWN



FOOTING DETAIL 2

ALL CORNERS, END, PULL & GATE POSTS SHALL HAVE CONCRETE FOOTINGS AS SHOWN

STORMWATER MANAGEMENT FACILITY FENCING

NOT TO SCALE

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Revision No.		Date:	
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Revision No.		Date:	
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COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

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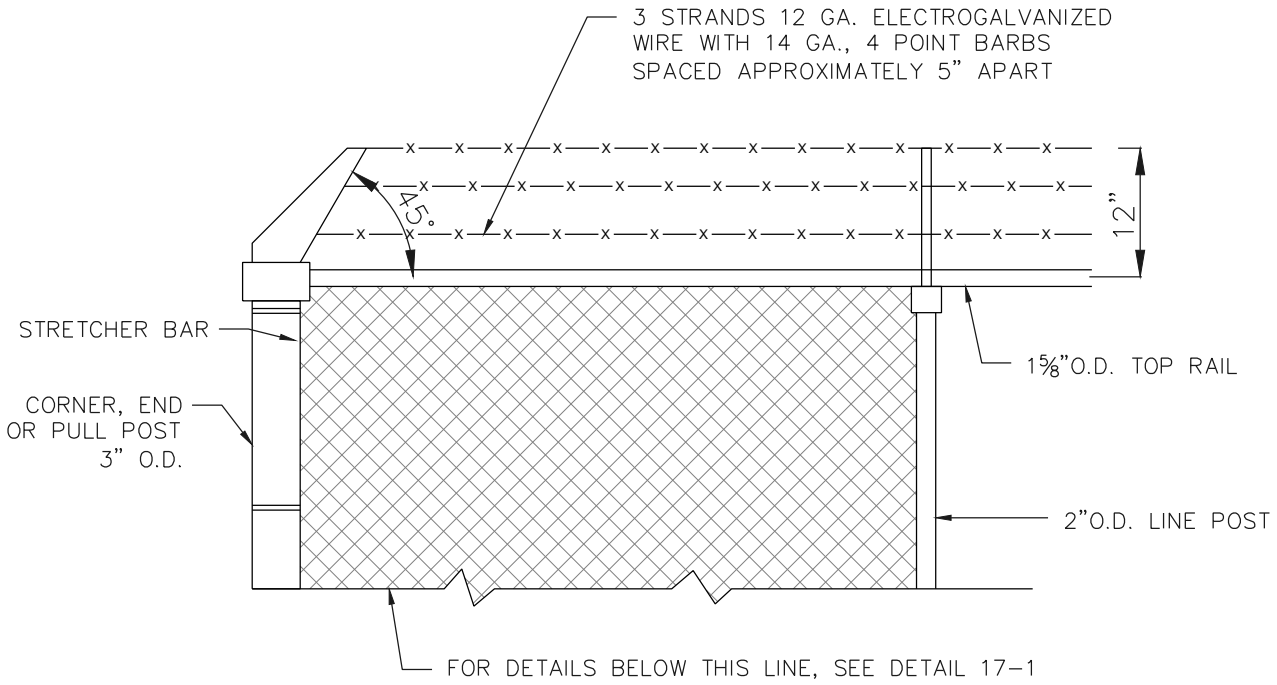
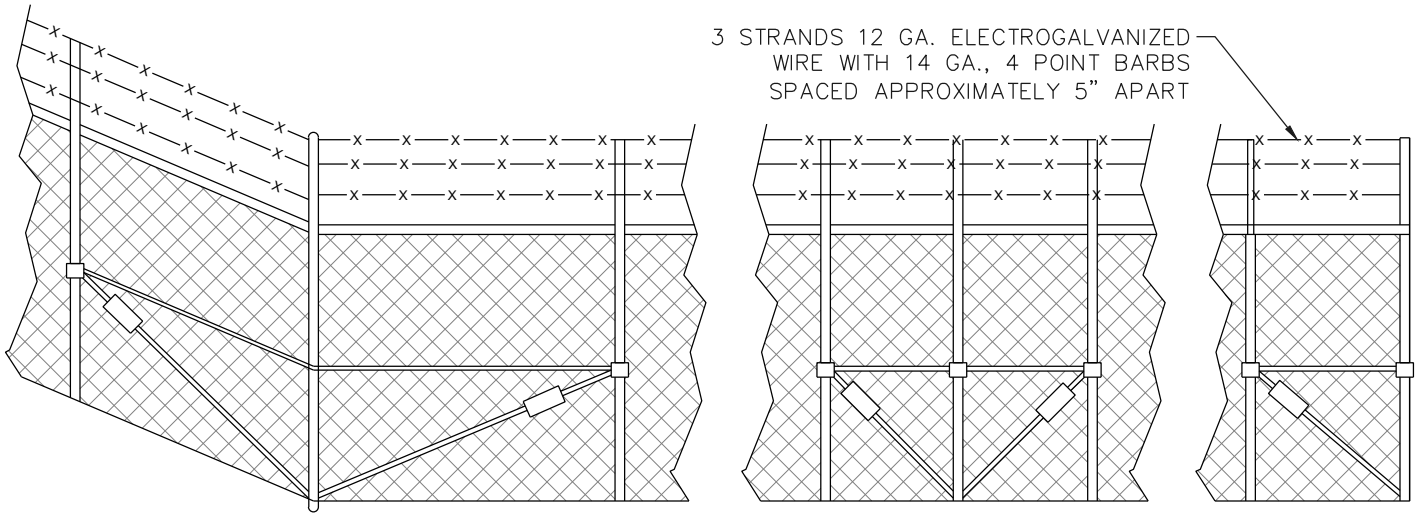
ISSUE DATE: 1/13/2022



DETAILS OF BARBED WIRE WITH EXTENSION ARMS FOR CHAIN LINK WIRE FENCE



METHOD OF BRACING END, CORNER, AND PULL POST

STORMWATER MANAGEMENT FACILITY FENCING

NOT TO SCALE

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Revision No.		Date:	
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COLUMBIA COUNTY
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17-1.2

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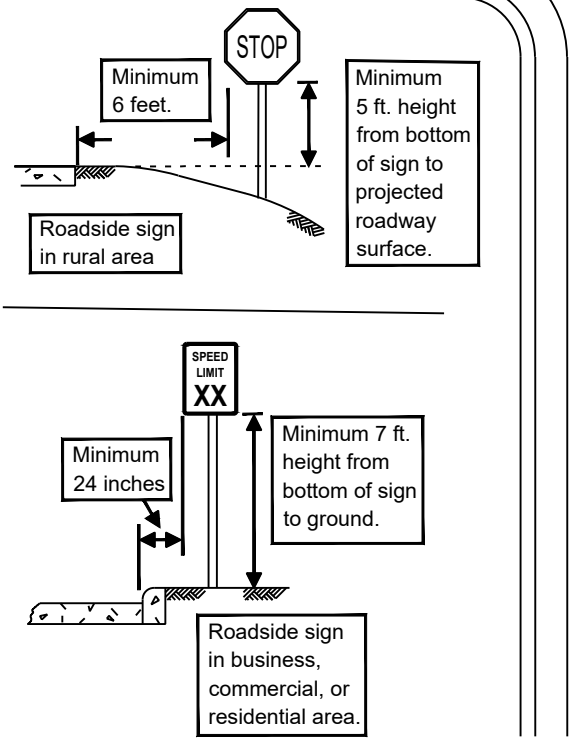

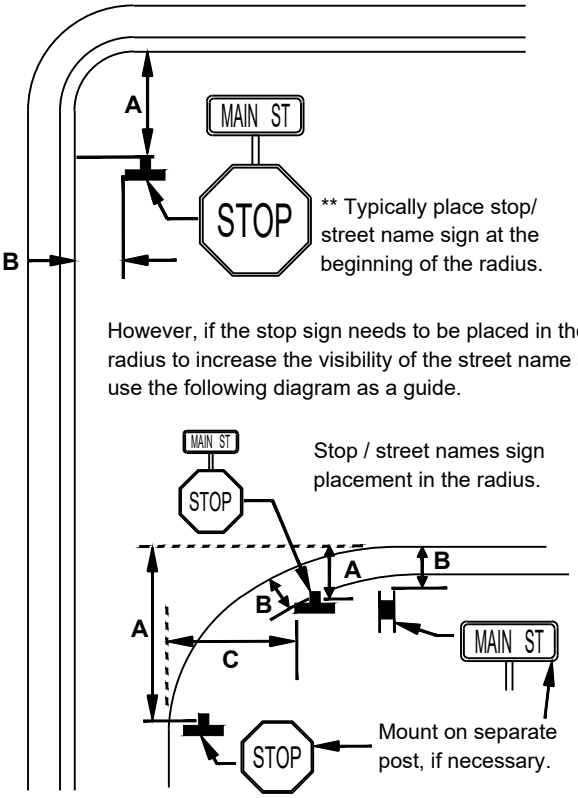

** Typically place stop/ street name sign at the beginning of the radius.

However, if the stop sign needs to be placed in the radius to increase the visibility of the street name sign, use the following diagram as a guide.

Stop / street names sign placement in the radius.

Mount on separate post, if necessary.

A: May vary, but MAXIMUM distance is 50 feet and MINIMUM distance is 6 feet from travelway. for a Stop Sign.
B: For curb (>6") & gutter streets, lateral offset to edge of sign should be minimum of 24 inches from back of curb. For all other streets (ditch, raised edge, rolled curb, etc.), lateral offset to edge of sign should be a minimum of 2 feet from edge of pavement/curb for < 25 MPH and lateral offset to edge of sign should be a minimum of six feet for speeds > 25 MPH.
C: Distance will vary based on best location, but should never exceed six feet from projected edge of pavement extended and still meet condition B, if street markers not visible for main street after determining best location for Stop Sign, mount makers on separate post.
Every effort should be made to reduce foliage in the intersection ROW so that the typical stop sign placement maybe achieved .

TRAFFIC CONTROL DEVICES STANDARD LOCATIONS

Standards are based on the Federal Highway Administration's Manual on Uniform Traffic Control Devices, 2009 Edition

NOT TO SCALE

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COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

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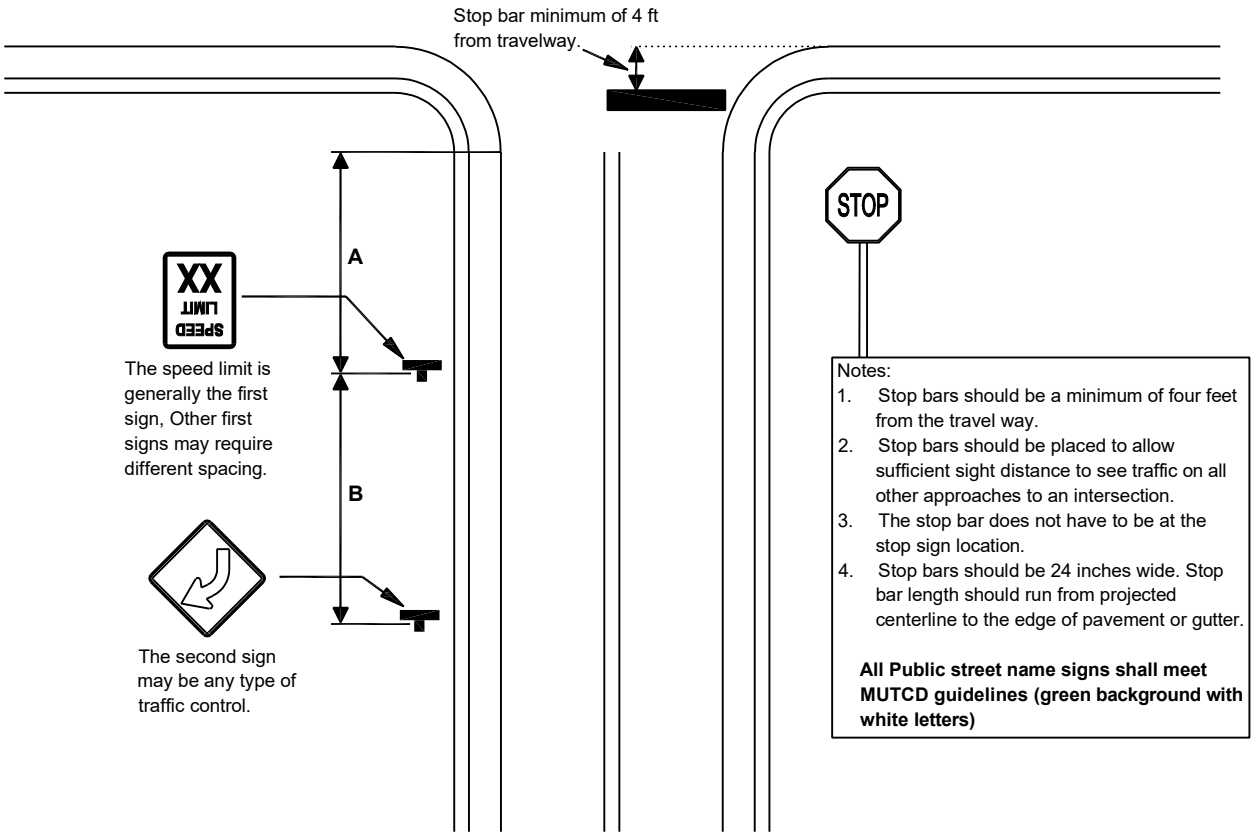
ISSUE DATE: 3/3/2022



Notes:
1. Stop bars should be a minimum of four feet from the travel way.
2. Stop bars should be placed to allow sufficient sight distance to see traffic on all other approaches to an intersection.
3. The stop bar does not have to be at the stop sign location.
4. Stop bars should be 24 inches wide. Stop bar length should run from projected centerline to the edge of pavement or gutter.

All Public street name signs shall meet MUTCD guidelines (green background with white letters)

Speed Limit of Road (MPH)	Distance Between Signs	
	A	B
25	100' to 200'	125'
30	125' to 225'	150'
35	200' to 300'	175'
40	300' to 400'	250'
45	325' to 450'	300'
50	350' to 500'	350'
55	400' to 550'	400'
60	450' to 600'	450'
65	500' to 650'	500'

A: Typical range of spacing between the first sign (typically speed limit) and the end of the radius (may increase distance based on lot sizes).
B: Desirable minimum spacing between signs.

Columbia County reserves the right to require additional signing, such as Stop Ahead, Curve Left, Cross Road, etc., as determined at the time of plan review or final platting.

Any other applicable sign installations should conform to the standards and requirements of the Federal Highway Administration's Manual on Uniform Traffic Control Devices, 2009 edition.

TRAFFIC CONTROL DEVICES STANDARD LOCATIONS

Standards are based on the Federal Highway Administration's Manual on Uniform Traffic Control Devices, 2009 Edition

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COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

T – 2

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SPEED LIMIT	"L"	"B"	"S"
30 MPH	90'	50'	135
35 MPH	125'	50'	160
40 MPH	160'	50'	210
45 MPH	270'	100'	235
50 MPH	300'	100'	285
55 MPH	330'	100'	310

NOTE:
STORAGE LENGTHS ("S") ARE THE MINIMUM LENGTHS REQUIRED. REDUCED LENGTHS, AS JUSTIFIED BY A TRAFFIC STUDY, MAY BE CONSIDERED BY THE COUNTY ENGINEER. BUT IN NO CASE SHALL BE LESS THAN 100' ON COLLECTOR ROADS OR 150' ON ARTERIAL ROADS.

MINIMUM LANE SHIFT TAPER LENGTHS FOR CENTER LEFT TURN LANES ARE BASED ON THE FOLLOWING EQUATIONS:
1. FOR POSTED SPEEDS LESS THAN OR EQUAL TO 40 MPH, $L=WS^2/60$.
2. FOR POSTED SPEEDS EQUAL TO OR GREATER THAN 45 MPH, $L=WS$.

WHERE: L= MINIMUM TAPER LENGTH
W = WIDTH OF THE OFFSET FROM CENTERLINE AND/OR THE EDGE OF PAVEMENT.
S = POSTED SPEED LIMIT
S^2 = SPEED RAISED TO THE POWER OF 2

THE ABOVE TABLE AND DRAWING ARE BASED ON A SYMMETRICAL WIDENING OF SIX FEET (6') ABOUT THE CENTERLINE OF THE EXISTING ROAD.

MINIMUM DESIGN ELEMENTS OF LEFT TURN LANES

SYMMETRICAL WIDENING ABOUT THE ℄

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COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

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T – 3

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SPEED LIMIT	"L"	"B"	"S"
30 MPH	180'	50'	135
35 MPH	250'	50'	160
40 MPH	320'	50'	210
45 MPH	540'	100'	235
50 MPH	600'	100'	285
55 MPH	660'	100'	310

NOTE:
STORAGE LENGTHS ("S") ARE THE MINIMUM LENGTHS REQUIRED. REDUCED LENGTHS, AS JUSTIFIED BY A TRAFFIC STUDY, MAY BE CONSIDERED BY THE COUNTY ENGINEER, BUT IN NO CASE SHALL BE LESS THAN 100' ON COLLECTOR ROADS OR 150' ON ARTERIAL ROADS..

MINIMUM LANE SHIFT TAPER LENGTHS FOR CENTER LEFT TURN LANES ARE BASED ON THE FOLLOWING EQUATIONS:
1. FOR POSTED SPEEDS LESS THAN OR EQUAL TO 40 MPH, $L=WS^2/60$.
2. FOR POSTED SPEEDS EQUAL TO OR GREATER THAN 45 MPH, $L=WS$.

WHERE: L= MINIMUM TAPER LENGTH
W = WIDTH OF THE OFFSET FROM CENTERLINE AND/OR THE EDGE OF PAVEMENT.
S = POSTED SPEED LIMIT
S^2 = SPEED RAISED TO THE POWER OF 2

THE ABOVE TABLE AND DRAWING ARE BASED ON A TWELVE FOOT (12') LANE SHIFT TO ONE SIDE OF THE ROAD TO PROVIDE THE CENTER TURN LANE. ALL DISTANCES ARE MINIMUMS.

MINIMUM DESIGN ELEMENTS OF LEFT TURN LANES

ASYMMETRICAL WIDENING

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NOTE:
1. TAPERS ARE NOT CURBED WHEN ADJOINING AN UNCURBED ROAD.

PREFERRED LENGTHS

SPEED LIMIT	"L"	"T"
25 MPH	50'	50'
30 MPH	75'	50'
35 MPH	100'	50'
40 MPH	150'	50'
45 MPH	175'	100'
50 MPH	225'	100'
55 MPH	250'	100'

NOTES:
1. STORAGE LENGTHS ("L") ARE DETERMINED BY THE TRAFFIC STUDY AND ARE THE MINIMUM LENGTHS.
2. FINAL STORAGE LENGTHS ("L") TO BE APPROVED BY THE COUNTY ENGINEER BASED ON FIELD CONDITIONS.

MINIMUM DESIGN ELEMENTS OF DECELERATION LANES

NOT TO SCALE

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COLUMBIA COUNTY
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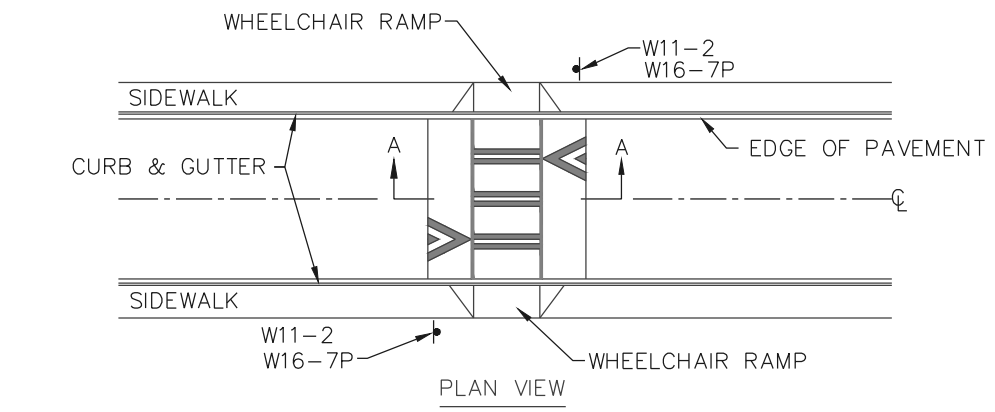
COLUMBIA COUNTY GEORGIA

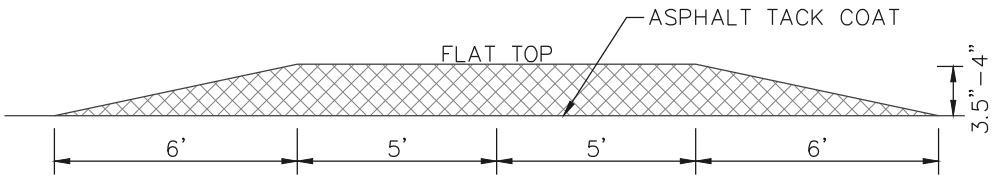
ENGINEERING SERVICES DIVISION

RAISED CROSSWALK

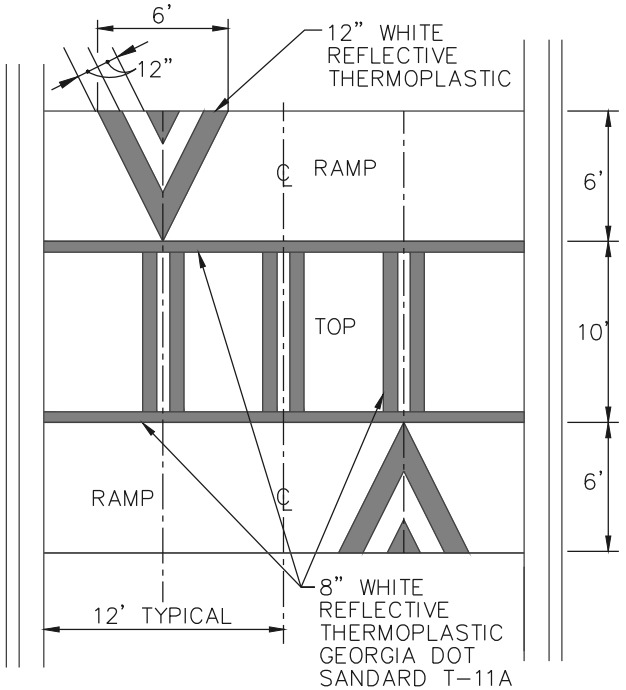
NOT TO SCALE



PLAN VIEW



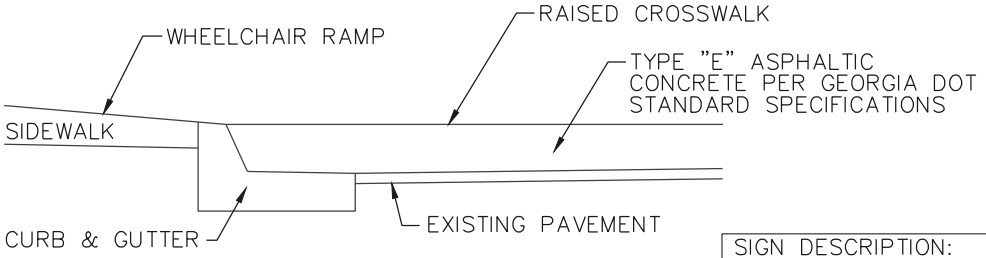
SECTION A-A



RAISED CROSSWALK MARKING DETAIL

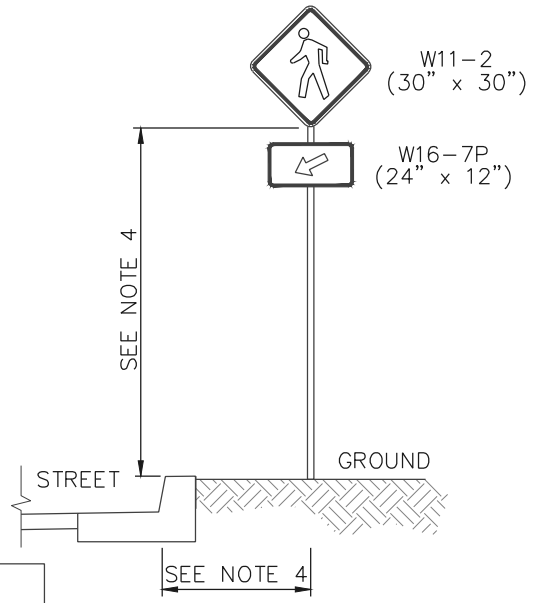
NOTES:

1. RAISED CROSSWALK MAY ONLY BE INSTALLED IN STREETS WITH GRADES LESS THAN 8%.
2. DROP INLETS ARE REQUIRED ON THE UPHILL SIDE OF THE RAISED CROSSWALK FOR DRAINAGE PURPOSES.
3. DRIVEWAYS SHALL NOT BE LOCATED WITHIN 5' OF RAISED CROSSWALK.
4. REFER TO TRAFFIC CONTROL DEVICES STANDARD LOCATIONS, DETAIL T-1 FOR SIGNAGE HEIGHT AND, LATERAL OFFSET DIMENSIONS.
5. SPEED HUMP SIGN (W17-1) WITH ADVISORY PLATE W13-1P (20 MPH) AND W16-9P (AHEAD) SHALL BE INSTALLED IN ADVANCE OF A RAISED CROSSWALK, IN BOTH DIRECTIONS OF TRAVEL. CONTRACTOR SHALL COORDINATE THE NUMBER AND LOCATION OF SIGNS WITH THE TRAFFIC DEPARTMENT PRIOR TO THE INSTALLATION OF RAISED CROSSWALKS.



SECTION B-B (WITH CURB)

SIGN DESCRIPTION:
W11-2 PEDESTRIAN
W16-7P DIAGONAL ARROW



TYPICAL SIGNAGE INSTALLATION

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T-6

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COLUMBIA COUNTY
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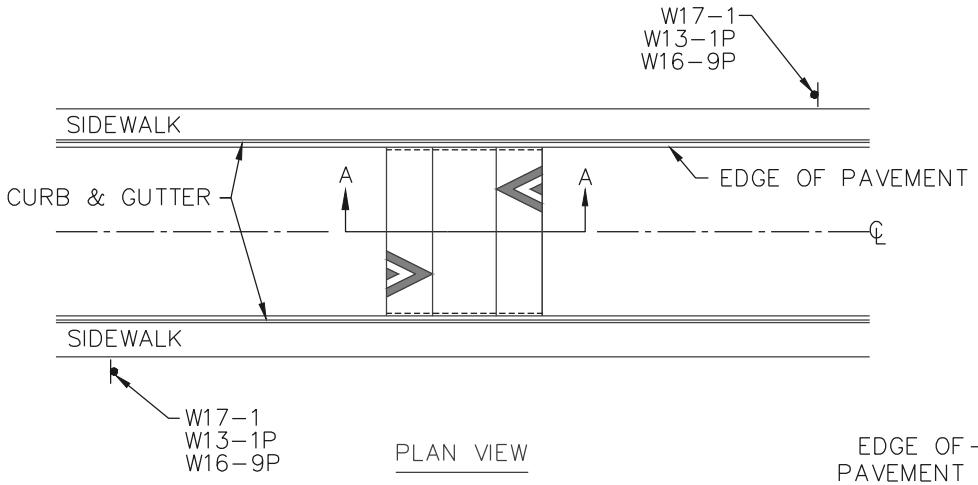
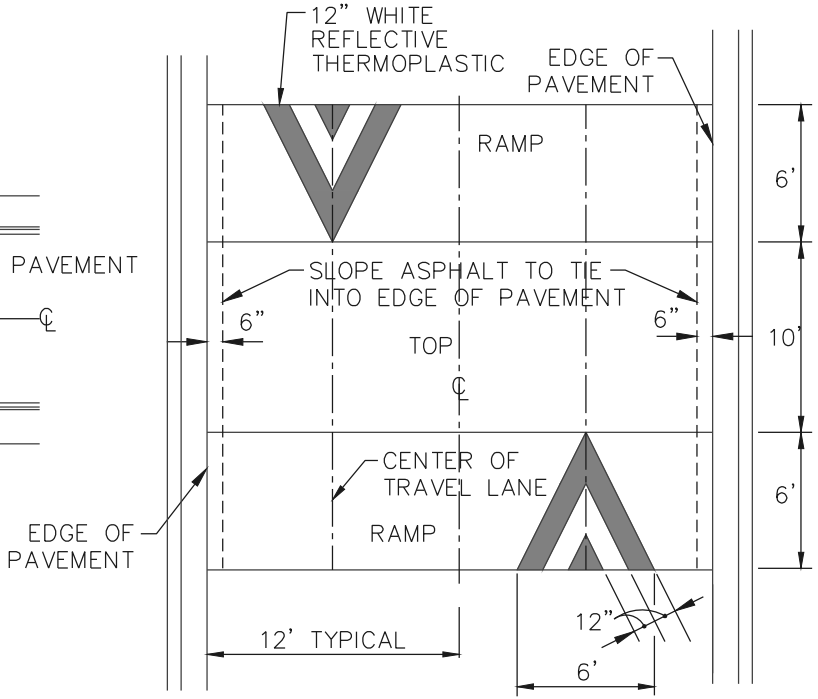
SPEED HUMP

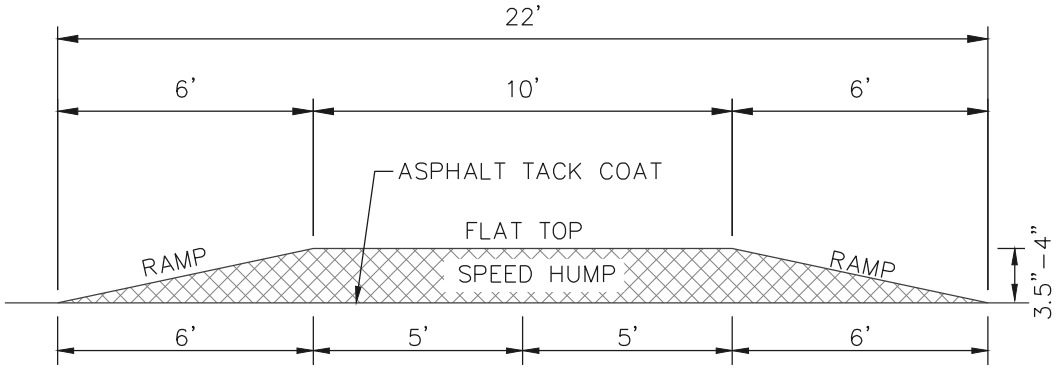
NOT TO SCALE



PLAN VIEW



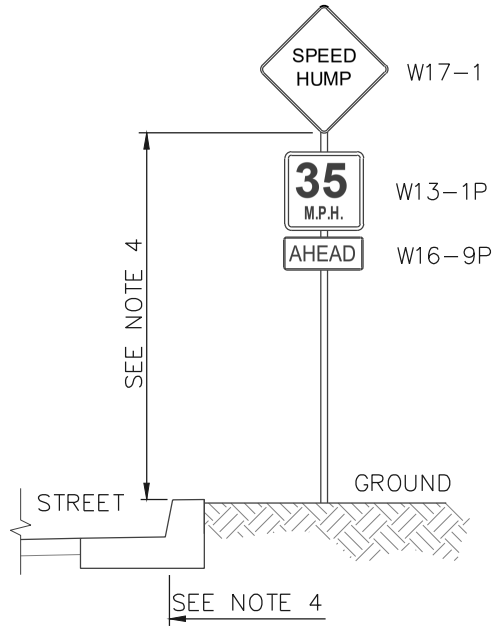
SPEED HUMP MARKING DETAIL



SECTION A–A

NOTES:

1. SPEED HUMP MAY ONLY BE INSTALLED IN STREETS WITH GRADES LESS THAN 8%
2. DRIVEWAYS SHALL NOT BE LOCATED WITHIN 5' OF SPEED HUMP.
3. REFER TO TRAFFIC CONTROL DEVICES STANDARD LOCATIONS, DETAIL T-1 FOR SIGNAGE HEIGHT AND LATERAL OFFSET DIMENSIONS.
4. SPEED HUMP SIGN (W17-1) WITH ADVISORY PLATE W13-1P (20 MPH) AND W16-9P (AHEAD) SHALL BE INSTALLED IN ADVANCE OF A SINGLE SPEED HUMP OR IN ADVANCE OF THE FIRST AND LAST SPEED HUMP OF A SERIES, IN BOTH DIRECTIONS OF TRAVEL. CONTRACTOR SHALL COORDINATE THE NUMBER AND LOCATION OF SIGNS WITH THE TRAFFIC DEPARTMENT PRIOR TO INSTALLATION OF SPEED HUMPS.



TYPICAL SIGNAGE INSTALLATION

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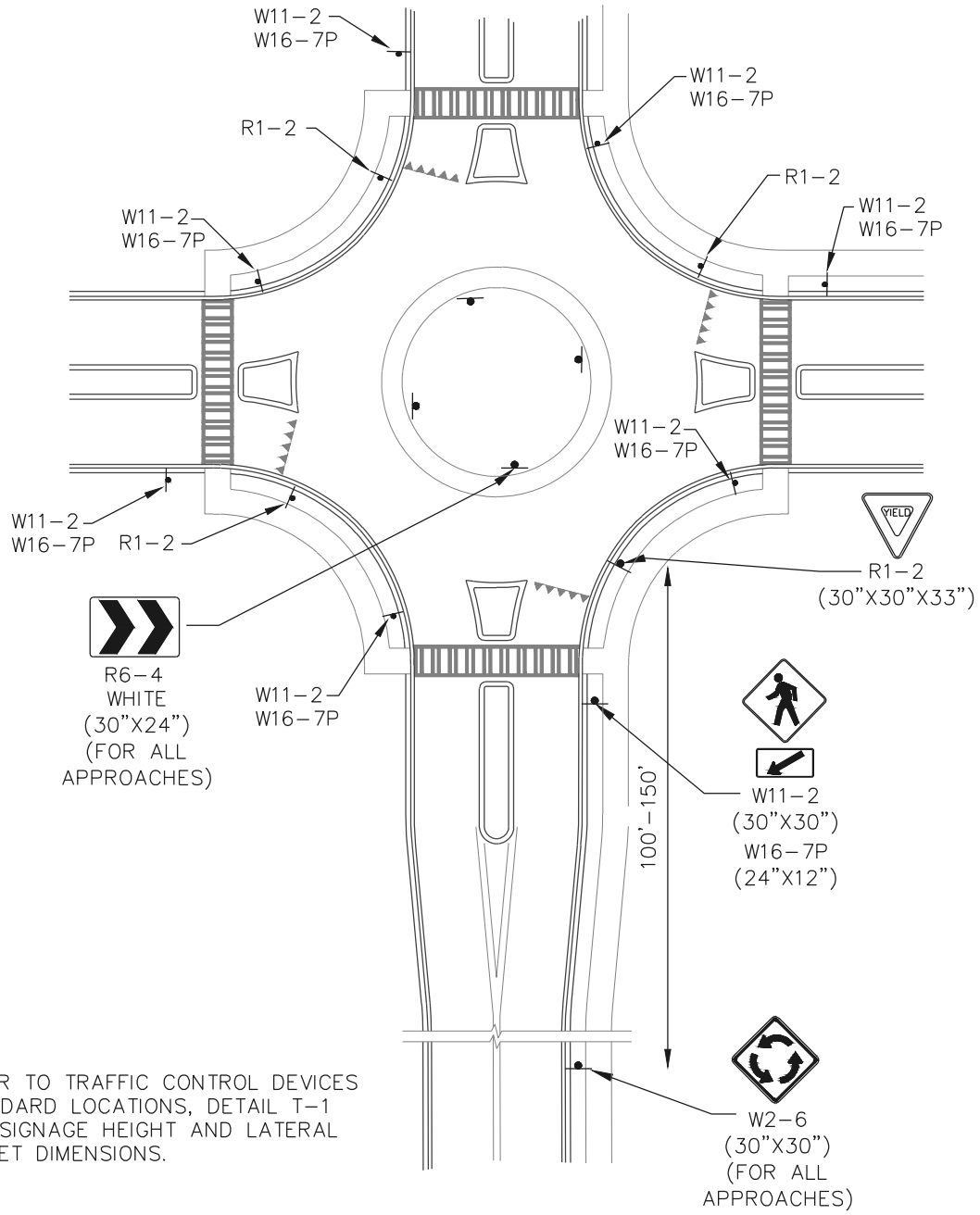

NOTE:
1. REFER TO TRAFFIC CONTROL DEVICES STANDARD LOCATIONS, DETAIL T-1 FOR SIGNAGE HEIGHT AND LATERAL OFFSET DIMENSIONS.

ROUNDABOUT SIGNAGE

NOT TO SCALE

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COLUMBIA COUNTY GEORGIA

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COLUMBIA COUNTY
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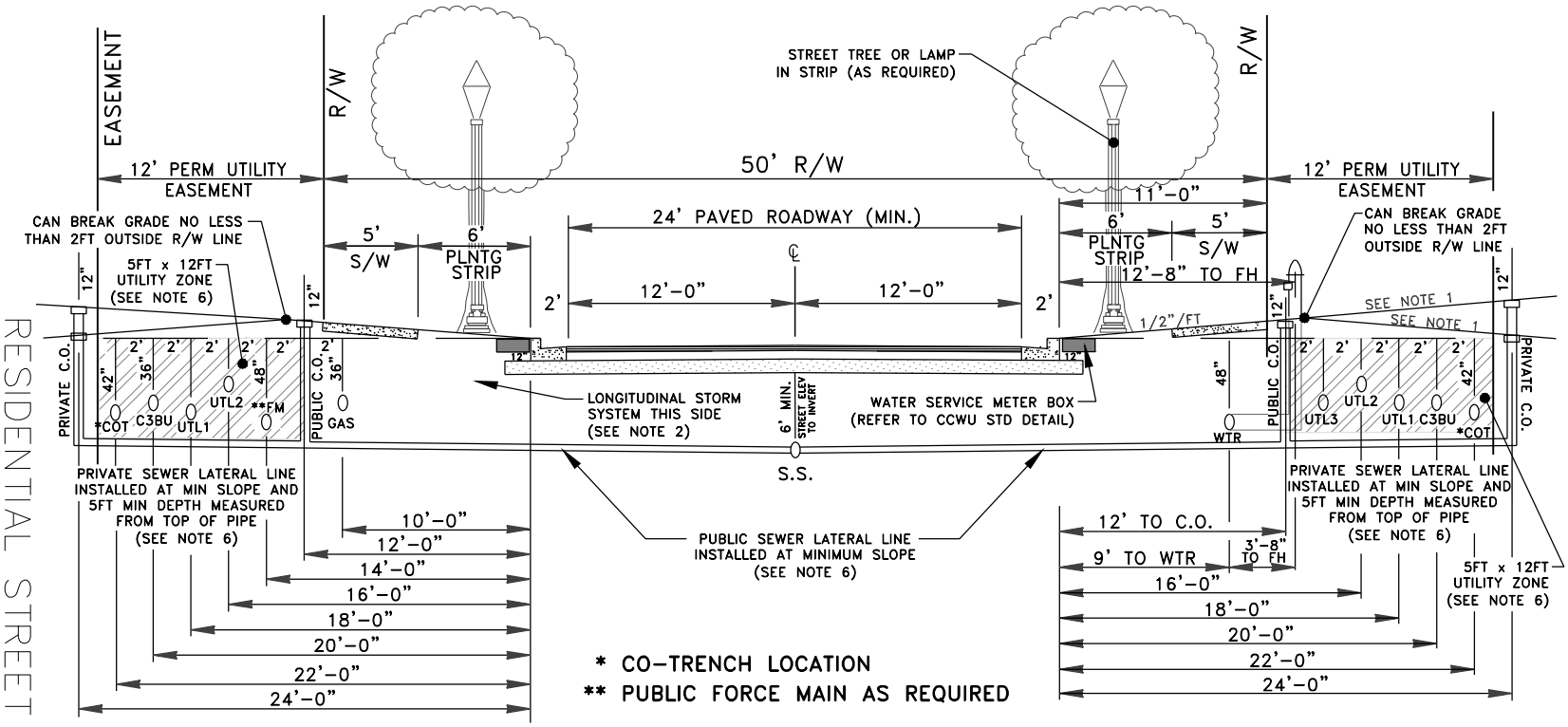
T-9

ISSUE DATE: 3/3/2022

RESIDENTIAL STREET UTILITY SECTION

6 Ft. PLANTER STRIP

NOT TO SCALE



RESIDENTIAL STREET UTILITY SECTION – 6 Ft. PLANTER STRIP

SINGLE FAMILY RESIDENTIAL W/ DRIVEWAY ACCESS

NOTES:

1. FULL WIDTH OF THE RIGHT-OF-WAY AND PERMANENT UTILITY EASEMENTS MUST BE CLEARED & GRADED WITH A SLOPE OF $\frac{1}{2}$"/FT. UTILITY EASEMENT CAN BE GRADED TO MAXIMUM 6:1 IF DESIGN DICTATES THE NEED FOR A STEEPER TRANSITION TO BUILDING PAD GRADE. PERMANENT UTILITY EASEMENT IS ALLOWED TO SLOPE UP OR DOWN. A DOWNSLOPE MUST BREAK NO LESS THAN 2FT OUTSIDE R/W LINE.
2. ALL STORM LINES SHALL BE LOCATED OPPOSITE WATER LINES. A PARALLELISM OF STORM AND WATER LINE ON SAME SIDE IS NOT PERMITTED. STORM PIPING UNDER PAVEMENT MUST BE KEPT TO A MINIMUM.
3. ALL UTILITY DEPTHS ARE BASED ON TOP OF CURB, NOT ELEVATION DIRECTLY OVER UTILITY. UTILITY DEPTH REQUIREMENTS VARY AND SHOULD ALTERNATE TO HELP LIMIT DAMAGES TO ADJACENT FACILITIES DURING FUTURE REPAIRS.
4. HYDRANT LEAD LENGTH IS REDUCED PER THIS CROSS SECTION. A HYDRANT ANCHOR TEE IS REQUIRED WITH VALVE ANCHORED DIRECTLY TO TEE. AN ANCHOR COUPLING SHALL BE USED TO CONNECT THE HYDRANT FOOT TO THE VALVE. TEE + VALVE + ANCHOR COUPLING + HYDRANT = 3'-8" LAYING LENGTH.
5. MINIMUM 20FT DISTANCE FROM WATERLINE TO RESIDENTIAL STRUCTURE.
6. PUBLIC SEWER LATERAL LINE SHALL MEET COUNTY SPECIFICATION FOR MINIMUM SLOPE REQUIREMENT TO THE PUBLIC CLEANOUT. AT THE PUBLIC CLEANOUT, CONTRACTOR/ENGINEER IS ALLOWED TO RAISE THE GRADE OF THE PRIVATE SEWER LATERAL LINE IN ORDER TO MEET THE ELEVATION REQUIREMENT TO THE STRUCTURE WHILE MAINTAINING THE 5 FOOT MINIMUM DEPTH INSIDE THE UTILITY ZONE. THE 5 FOOT MINIMUM DEPTH IN UTILITY ZONE IS MEASURED FROM TOP OF CURB TO TOP OF LATERAL PIPE. PRIVATE SEWER LINE SHALL MEET THE COUNTY SPECIFICATION FOR MINIMUM SLOPE REQUIREMENT TO THE PRIVATE CLEANOUT.

RESIDENTIAL STREET UTILITY SECTION – 2 Ft. PLANTER STRIP

SINGLE FAMILY RESIDENTIAL W/ DRIVEWAY ACCESS

NOTES:

1. FULL WIDTH OF THE RIGHT-OF-WAY AND PERMANENT UTILITY EASEMENTS MUST BE CLEARED & GRADED WITH A SLOPE OF ½"/FT. UTILITY EASEMENT CAN BE GRADED TO MAXIMUM 6:1 IF DESIGN DICTATES THE NEED FOR A STEEPER TRANSITION TO BUILDING PAD GRADE. PERMANENT UTILITY EASEMENT IS ALLOWED TO SLOPE UP OR DOWN.
2. ALL STORM LINES SHALL BE LOCATED OPPOSITE WATER LINES. A PARALLELISM OF STORM AND WATER LINE ON SAME SIDE IS NOT PERMITTED. STORM PIPING UNDER PAVEMENT MUST BE KEPT TO A MINIMUM.
3. ALL UTILITY DEPTHS ARE BASED ON TOP OF CURB, NOT ELEVATION DIRECTLY OVER UTILITY. UTILITY DEPTH REQUIREMENTS VARY AND SHOULD ALTERNATE TO HELP LIMIT DAMAGES TO ADJACENT FACILITIES DURING FUTURE REPAIRS.
4. MINIMUM 20FT DISTANCE FROM WATERLINE TO RESIDENTIAL STRUCTURE.
5. PUBLIC SEWER LATERAL LINE SHALL MEET COUNTY SPECIFICATION FOR MINIMUM SLOPE REQUIREMENT TO THE PUBLIC CLEANOUT. AT THE PUBLIC CLEANOUT, CONTRACTOR/ENGINEER IS ALLOWED TO RAISE THE GRADE OF THE PRIVATE SEWER LATERAL LINE IN ORDER TO MEET THE ELEVATION REQUIREMENT TO THE STRUCTURE WHILE MAINTAINING THE 5 FOOT MINIMUM DEPTH INSIDE THE UTILITY ZONE. THE 5 FOOT MINIMUM DEPTH IN UTILITY ZONE IS MEASURED FROM TOP OF CURB TO TOP OF LATERAL PIPE. PRIVATE SEWER LINE SHALL MEET THE COUNTY SPECIFICATION FOR MINIMUM SLOPE REQUIREMENT TO THE PRIVATE CLEANOUT.

RESIDENTIAL STREET UTILITY SECTION

2 Ft. PLANTER STRIP

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COLUMBIA COUNTY GEORGIA

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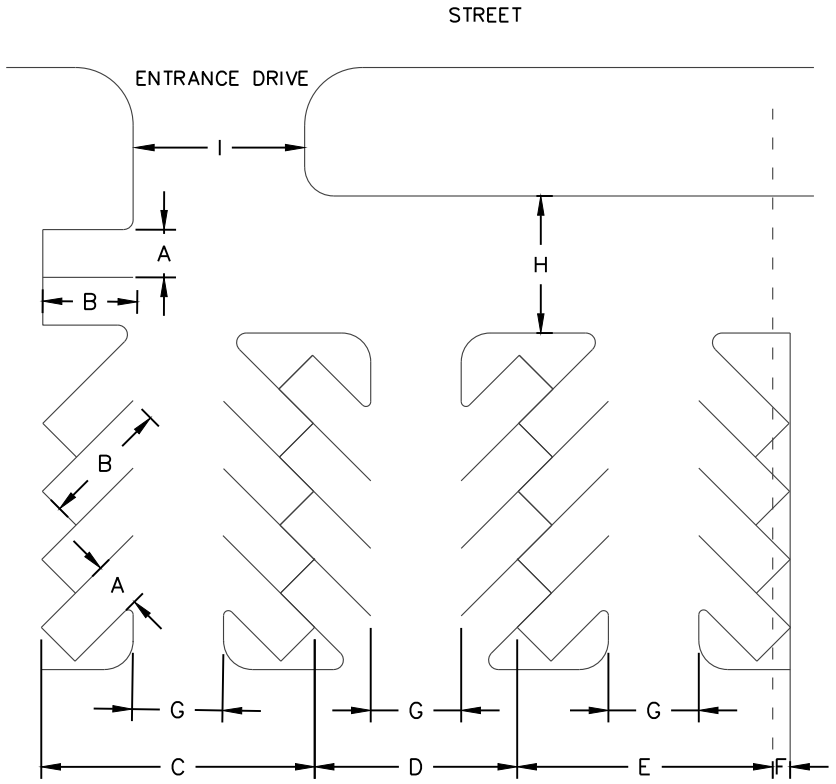

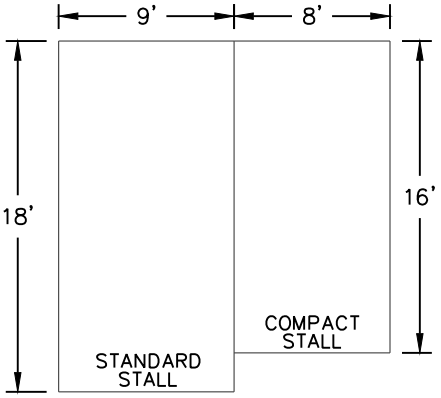

		GROUP I: STANDARD CARS					GROUP II: COMPACT CARS				
		° ANGLE OF PARK					° ANGLE OF PARK				
DIMENSION	KEY	0°	45°	60°	75°	90°	0°	45°	60°	75°	90°
Stall Width	A	8'–6"	9'–0"	9'–0"	9'–0"	9'–0"	7'–6"	8'–0"	8'–0"	8'–0"	8'–0"
Stall Depth	B	24'–0"	18'–0"	18'–0"	18'–0"	18'–0"	22'–0"	16'–0"	16'–0"	16'–0"	16'–0"
Module,Wall to Interlock	C	–	60'–0"	60'–0"	60'–0"	60'–0"	–	60'–0"	60'–0"	60'–0"	60'–0"
Module, Interlocking	D	–	60'–0"	60'–0"	60'–0"	60'–0"	–	60'–0"	60'–0"	60'–0"	60'–0"
Module, Interlocking to Curb Face	E	–	58'–0"	58'–0"	58'–0"	58'–0"	–	58'–0"	58'–0"	58'–0"	58'–0"
Bumper Overhang (Typical)	F	2'–6"	2'–6"	2'–6"	2'–6"	2'–6"	2'–6"	2'–6"	2'–6"	2'–6"	2'–6"
Aisle Width (One–Way)	G	12'–0"	18'–0"	19'–0"	20'–0"	24'–0"	12'–0"	18'–0"	22'–0"	22'–0"	24'–0"
Aisle Width (Two–Way)	G	24'–0"	22'–0"	22'–0"	24'–0"	24'–0"	24'–0"	22'–0"	22'–0"	24'–0"	24'–0"
Cross Aisle/Access Drive (One–Way)	H	14'–0"	14'–0"	14'–0"	14'–0"	14'–0"	14'–0"	14'–0"	14'–0"	14'–0"	14'–0"
Cross Aisle/Access Drive (Two–Way)	H	24'–0"	24'–0"	24'–0"	24'–0"	24'–0"	24'–0"	24'–0"	24'–0"	24'–0"	24'–0"
Entrance Drive (One–Way)	I	Note: Driveway width and all access shall be in accordance with the "GDOT Driveway & Encroachment Manual".									
Entrance Drive (Two–Way)	I										

NOTES:

1. SEE SECTION "90–140 LANDSCAPING" OF COLUMBIA COUNTY CODE REGARDING LANDSCAPE REQUIREMENTS FOR PARKING LOTS AND ROAD FRONTAGES. PLEASE ALSO REVIEW SECTION "90–139 BUFFERS" AND "SCREENING REGARDING DESIGN OF BUFFERS."
2. COMPACT SPACES MUST BE APPROVED BY THE PLANNING DEPARTMENT DURING SITE PLAN REVIEW. SIGNAGE AND/OR PAVEMENT MARKINGS INDICATING COMPACT SPACES SHALL BE REQUIRED."
3. TYPICAL DIMENSIONS SHOWN MAY REQUIRE ADJUSTMENTS BY THE COUNTY FIRE MARSHAL AND/OR FIRE CHIEF IF WARRANTED BY SITE CONDITIONS.

PARKING LAYOUT DIMENSIONS

NOT TO SCALE

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COLUMBIA COUNTY GEORGIA

ENGINEERING SERVICES DIVISION

STANDARD DETAIL NUMBER

T–11

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SECTION 323113

CHAIN LINK FENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Privacy slats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of fence..

1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Sample warranty.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 FENCE FRAMEWORK

A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:

1. Fence Height: As indicated on Drawings

2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.

a. Line Post: 4.0 inches in diameter.
b. End, Corner, and Pull Posts:4.0 inches in diameter.

3. Horizontal Framework Members: Intermediate, top and bottom rails according to ASTM F1043.

4. Metallic Coating for Steel Framework:

    a. Type A zinc coating.
    b. Type B zinc with organic overcoat.
    c. External, Type B zinc with organic overcoat and internal, Type D zinc-pigmented coating.
    d. Type C, Zn-5-Al-MM alloy coating.
    e. Coatings: Any coating above.

5. Polymer coating over metallic coating.

2.3 FITTINGS

A. Provide fittings according to ASTM F626.

B. Razor Wire Arms: Pressed steel or cast iron, with clips, slots, or other means for attaching strands of razor wire, and means for attaching to posts for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: Type II, vertical arm.

C. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

2.4 PRIVACY SLATS

A. Tubular Polyethylene Slats: Minimum 0.023-inch-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with vandal-resistant fasteners and lock strips, fins for increased privacy factor.

B. Color: As selected by Architect from manufacturer's full range.

2.5 RAZOR WIRE

A. Steel Razor Wire: ASTM A121, one-strand razor wire, 0.1 -inch-diameter line wire with 0.087-inch-, four-point flat razor points spaced not more than 1.6 inches o.c.

1. Aluminum Coating: Type A.
2. Zinc Coating: Type Z, Class 3.

2.6 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete with mechanical anchors at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
    b. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 96 inches o.c.

F. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top of fence fabric.

G. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. Vertically for privacy factor of 90 to 95.

H. Razor Wire: Install razor wire uniformly spaced, angled toward security side of fence. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

3.4 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 323113

SECTION 323113.13
VEHICLE LOCKING GATE SYSTEM

PART – 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. The work in this section shall include furnishing all labor, materials, equipment and appliances necessary to complete all detention grade enclosed drive motorized sliding gate(s), detention grade pedestrian swing gate(s) and detention grade pedestrian sliding gate(s) required for this project in strict accordance with this section of specifications and drawings.

B. Related Sections: The following sections contain requirements that relate to this section.

1. Division 03 00 00 Section “Cast-in-Place Concrete:
2. Division 26 00 00 Sections for electrical requirements.
3. Division 17 Sections for interfacing with security electronic controls.

1.03 REFERENCES

A. Underwriters Laboratory Vehicle Gate Operator Requirements (UL 325). (See 2.1 – D4)

B. American Welding Society AWS D1.1 / D1.1M Structural Welding Code. (See 1.05 – D2)

C. ASTM F 1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (galvanized) Welded, for Fence Structures. (See 1.05 – D1)

D. ASCE – 7: Minimum Design Loads for Buildings and Other Structures. (See 1.05 – D3)

1.04 DEFINITIONS

A. Technical Advisor(s): An employee of the company producing the system who is certified in writing by the manufacturer to be technically qualified in design, installation, and servicing of the required gate systems. Personnel involved solely in sales do not qualify.

1.05 SUBMITTALS

A. General: Submit following in according to Conditions of Contract and Division 1 Specification Section.

B. Product Data: Include details of construction relative to materials, dimensions of individual components, and gate. Provide roughing-in diagrams, operating instructions, and maintenance information. Include the following:

1. Setting drawings, templates, and installation instructions for built-in or embedded anchor devices.
2. Motors: Indicate nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.
3. Detailed description of operation.

C. Shop Drawings: For special components and installations not dimensioned or detailed in manufacturer’s data sheets.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring and between components provided by gate operator manufacturer and those provided by others.

2. Foundation details for operator.

D. CERTIFICATIONS

1. Gate in Compliance with ASTM F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (galvanized) welded, for Fence Structures. (See 1.03 C)
2. Gate manufacturer shall provide independent certification as to the use of a documented Welding Procedure Specification and Procedure Qualification Record to insure conformance to the AWS D1.2 welding Code. Upon request, Individual Certificates of Welder Qualification documenting successful completion of the requirements of the AWS D1.2 code shall also be provided. (See 1.03 – B).
3. Gate is to be designed to meet specified ASCE-7 Wind Load requirements with the gate in the closed and latched condition only. Typical gate design is expected to operate satisfactorily in winds up to 30 MPH. Depending on the gate panel infill, winds higher than 30 MPH may cause gate operational problems (if automated, operator entrapment may trigger, gate panel may not engage receiver). For sites with higher operational, non-typical, or specified wind loadings; the manufacturer should be advised of the site conditions and a specifically engineered design will be offered. (See 1.03 – D).
4. The gate operator shall be in compliance with UL 325 as evidenced by UL listing label attached to gate operator. (See 1.03 – A)

E. Technical Advisor's Qualifications Data:

1. Name, business address and telephone numbers of technical advisor(s).
2. Written certification from gate systems manufacturer that advisor is technically qualified in design, installation and servicing of products.
3. Technical Advisor: The Technical Advisor (for each type of gate system) shall provide the following services:
   a) Render advice regarding, pre-construction discussions with other involved trades (controls and electrical contractors) and final adjustment of the gate system(s)
   b) Witness final system test and then certify with an affidavit that the gate system(s) is installed in accordance with the contract documents and is operating properly.
   c) Train facility personnel on the operation and maintenance of the gate system(s) a minimum of 2 one-hour sessions.
   d) Answer questions that might arise.

1.06 CONTRACT CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data for each Gate Type: Deliver 3 copies of instructions for operation, maintenance, recommendations, and parts manuals covering the installed products to the Owners Representative.

B. Certification: Deliver to the Owners Representative written certification from the manufacturer's technical advisor that the gate systems and accessories are installed and operating properly. Include System Acceptance Test Report as per specification 3.3.

C. Selected manufacturer shall furnish an extended 2-year warranty. The manufacturer shall warrant the operator parts against failure resulting from normal operation of the system for a period of 2 years from the date of purchase. "Failure" is defined as a factory defect, thereby preventing normal movement of the system.

1.07 MAINTENANCE

A. Spare Parts: Furnish the following and store at the site where directed:

1. Sliding Gate – Mechanical: One reduction gear assembly, one full-length chain and repair links and one crank handle.
2. Sliding Gate Operator – Electrical: one motor, two limit switches, four limit nuts, one transformer, one APEX II controller, one thermostat, one lock column status switch with short arm, one motor box cage heater and one gearbox immersion heater.
3. Required amounts of recommended lubricants for 3 years of service.

PART - 2 PRODUCTS

2.1 VEHICLE SALLYPORT LOCKING SYSTEM(S):

A. Fully integrated detention grade overhead sliding gate system with enclosed drive and three-point mechanical locking capability. The entire assembly shall be encased in a hot-dip galvanized steel enclosure protecting both the drive and locking assemblies from possible inmate tampering and poor operation due to inclement weather. Detention grade sallyport locking system must be tamper resistant. Exposed drive systems (chain or rail drive) do not meet this requirement.

1. Gate manufacturer shall provide independent certification as to the use of a documented Welding Procedure Specification and Procedure Qualification Record to insure conformance with the AWS D1.1 welding code. Individual Certificates of Welder Qualification documenting successful completion of the requirements of the AWS D1.1M code shall also be provided.

B. MANUFACTURER:

1. Tymetal Corp. Model PLUSS is the design standard
2. Southern Folger Model “J”
3. Equivalent enclosed drive three-point mechanical locking system meeting the requirements of 2.1-A.

C. SYSTEM DIMENSIONS:

1. Each overhead locking system shall have a clear opening height and clear opening width as shown on the detail drawings.

D. SYSTEM FUNCTIONS:

1. System is designed to operate overhead sliding device.
2. System shall be designed so that gate movement from the closed position is impossible except by electric or mechanical means.

E. VARIABLE SPEED-RATE of TRAVEL:

1. The vehicle locking system shall have the ability to achieve a maximum gate speed of 1.5 feet per second, and shall be equipped with soft-start and soft-stop function to prevent shock load to the gate panel and locking system. Gate speed shall be adjustable and as selected by the facility at the project site.

F. MOTOR:

1. Controller/motor assembly shall meet the requirements of UL 325 (See 1.03-A).
2. Motor Size: The electrical motor shall be 1 HP, 230VAC, 3 Phase as produced by a nationally recognized manufacturer.
3. AC Drive: The variable frequency drive unit shall allow for programmable speeds and programmable soft-start and soft-stop features.

4. Overload Protection: Motors shall be protected against overload by either a thermal or a current sensing overload device.
5. Gear (Box) Reducer: The self-enclosed gear-head gearbox shall be manufactured as a single unit, and shall consist of hardened steel, machine cut worm and mating bronze gear running in oil bath. Oil shall be #460 viscosity grade oil with a fluid pour point of –22 degrees F. The gearbox shall perform the following functions:
   a) Adjustable Clutching Device.
   b) Manual disconnect by crank handle.
6. Gear Box Heater: Operator shall include internal gearbox heater and a heater strip for the control box.
7. Manual Operation: A crank handle, located at ground level in the motor box, shall provide a two-step emergency procedure for manual operation:
   a) Unlock and open motor-box door.
   b) Fold out handle and crank gate opened or closed.
8. Limits: The operator shall be equipped with an integral limit system, providing accurate settings to control the open and close positions of the gate, and shall not be affected by manual operation or motor removal.
9. Control Circuit: U.L. listed operator shall have 5v dc controls.
10. Control wiring: The electrical contractor shall supply all exterior control wiring.
11. Audio Alarm: This alarm shall have a dual function.
    a) The first function shall be as a warning prior to gate movement. When the motor control board recognizes a command, this alarm shall be activated three (3) seconds before the motor is energized and the gate begins to move. This shall be continuously activated while the gate is in motion.
12. Main Power Disconnect Switch and Wiring Compartment: When this switch is in the OFF position, the main power shall be disconnected from the Variable Speed Drive, Motor Control Board and power transformer(s).
13. Speed: The gate operator speed shall be fully programmable allowing a maximum speed of 2.0 feet per second.
14. Operators shall have an isolated low voltage (24V) secondary circuit supplied by a Class II transformer (24 VDC with a .5 AMP) to provide separate power for external control devices.

G. MOTOR HOUSING:

1. Water Resistant Motor Box: The motor box shall be constructed of 10-gauge sheet steel, hot-dip galvanized per ASTM 123, gasketed and located at ground level for easy maintenance.
2. Security Hinges and Tamper Resistant Security Screws: Security hinges and screws shall be furnished to secure operator enclosure components.
3. Motor Box Lock: Motor box shall be locked with a mogul lock or paracentric dead lock. Lock type to be selected during the submittal process. Manufacturer to ship motor box with a construction key code. Contractor to furnish facility specific key code (keys and lock cylinders).

H. SYSTEM COMPONENTS:

1. Overhead Track Assembly:
   a) Manufacturer's structural steel shapes shall contain all the required components to support and encase both the drive and locking assemblies. The steel structural channels shall be hot-dipped galvanized after fabrication.
2. Bottom Guides: Bottom guides on plates: bottom guides shall be constructed of 3/8" x 2 ½" (9.525 mm x 63.5 mm) flat steel, welded to a ¼" x 5" x 10 ½" (6mm x 127mm x 254mm) steel plate, shall be lagged to the concrete footing or as otherwise specified for vehicle crash gates.
3. Locking Column: The locking column is constructed of a W-4 "h" beam @ 13 lbs/lf with a removable steel cover, secured with security screws.
4. Locking Tangs: Three locking tangs to be affixed to the leading edge of the gate panel to provide positive locking into the locking column.
5. Posts: Double set of support posts shall be minimum 4" OD galvanized steel with concrete footings as specified by the design team.
6. Gate Guide Angle: Gate guide angle shall consist of a 2 ½" x 1 ½" x ¼" steel angle attached to the bottom of the gate panel running its full length or as otherwise specified for vehicle crash gates.

I. VEHICLE GATE PANEL:

1. Gate panel shall be manufactured with galvanized steel pipe meeting the manufacturer's requirements. Gate frame shall be welded to form a rigid panel. Gate operator manufacturer must supply the gate panel equipment with truss rods.
2. Outer Support Members: SCH 40 (grade A) hot dip galvanized steel pipe 2.375" O.D. weighing 3.65 lbs. per. lin. ft. Grade B steel tubing 2.375" O.Dweight may differ depending on manufacturer. Product must be equal to SCH 40.
3. Inner Support Member: SCH 40 (grade A) hot dip galvanized steel pipe 1.875" O.D. weighing 2.72 lbs. per. lin. ft. Grade B steel tubing 1.875" O.D. weight may differ depending on manufacturer. Product must be equal to SCH 40.
4. Gate Panel shall be trussed in accordance with manufacturer's specifications.
5. Gate Panel Filler: Standard infill to be 2" x 2" x 9-gauge aluminized steel chain link.
   a) Other options for infill are available. Contact Tymetal for further options.

2.2 VEHICLE LOCKING SYSTEM SEQUENCE OF OPERATION

A. Supervised Application:

B. Constant pressure on the pushbutton control, with the locking device in sight, is required as a primary entrapment protection device to keep the gate in motion. When the pushbutton is released, the gate will stop.

C. Controls for electrically interlocked sliding gates:

1. Electrically interlock gates in each sallyport to prevent unlocking of gate if any companion gate is in the unlocked position. Only one gate can be in the Open position at any one time. Exception: a key operated interlock bypass switch allows gate(s) to be opened for maintenance without preventing operation of the companion gate(s). The key is non-removable when the interlock circuit is bypassed.
2. Control Functions: Control console will operate three (3)gates. Gates shall be interlocked. Refer to electrical drawings, coordinate with the manufacturer and the Owner on tying new system into existing system.

   Interlock #1 _____

Interlock #2 _____

Interlock #3_____

Console Type: Console shall be for interior use, and shall be a desk mounted type.

Gate Opening: Is initiated by pressing and holding the OPEN push-button.

Gate Closing: By initiated by pressing and holding the CLOSED push-button.

Indication Lights: A green indication light illuminates when the gate is completely closed and locked. A red indication light illuminates under all other conditions.

Resuming Movement: Gate movement may be reused in either direction by pushing and holding the appropriate push-button.

3. Wiring: All wiring shall be concealed in proper conduit.
4. Emergency Manual Control: Manual control mechanism to permit the unlocking and manual operation of the sliding gates by means of a manual release.
5. Control Wiring: Coordinate all control wiring and conduit needs with the Electrical Contractor. The electrical contractor is responsible for all exterior electrical components.

D. The installing contractor shall be responsible to ensure that appropriate external primary entrapment safety devices be installed for the specific site conditions to protect all potential entrapment zones on vehicle gates.

2.3 FINISH

A. Galvanizing:

All exposed system parts shall be zinc galvanized or as otherwise specified.

PART - 3 EXECUTION

3.1 SITE INSPECTION

A. Final grades and installation conditions shall be examined. Installation shall not begin until all unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Equipment in this section shall be installed in strict accordance with the company's printed instructions unless otherwise shown on the contract drawings.

3.3 FIELD QUALITY CONTROL

A. General:

1. Pre-construction meeting that includes the factory construction manager.
2. Concrete Embedment: Factory supervisor shall be on site to inspect the work of the selected installation crew to insure compliance with manufacturers specifications
3. Commissioning: Facility staff training course shall last for a minimum time period of 4 hours and shall include the review of all installed systems, all controls and troubleshooting of any apparent or potential operation issues. Commissioning to be provided by factory staff only.

B. Preliminary System Test:

1. Preparation: Have the Technical Advisor adjust the complete system and then operate it long enough to assure that it is performing properly.
2. Run a preliminary test for each system:

a) Determining whether the system is in a suitable condition to conduct the acceptance test.

b) Checking and adjusting equipment.

c) Training facility personnel.

C. System Acceptance Test:

1. Preparation: Notify the Owner's Representative at least three working days prior to the test so arrangements can be made to have a Facility Representative witness the test.
2. Test each system function step by step.
3. Supply all equipment necessary for system adjustment and testing.
4. Test and Explain Safety Features:

   a) Each system feature and device is a separate component of the gate system.

   b) Ensure that all instructions for mechanical components, safety devices and the gate operator are available for everyone who will be using the gate system.

   c) The warning signs shipped with the gate operator must be installed in a prominent position on both sides of the gate.

5. Ensure the owner is clear with regard to the safety points concerning the basic operational guidelines of the safety features of the gate operator system. These safety points are listed in the operator manual and must be read prior to system use.
6. Submit written report of test results signed by Technical Advisor and the Owner's representative.

END OF SECTION 323113.13

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SECTION 323913.16

REMOVABLE SECURITY BOLLARDS

PART 1 - GENERAL

1.0 Scope

This specification defines the procurement of a U.S. Department of State designed HIGH SECURITY Bollard manufactured by Ameristar Perimeter Security USA, Inc.

ASP DS 22-FIXED
ASP DS 22-Removable

System Configuration:
The basic system comprises of one Fixed or removable High Security Bollard. Multiple bollards can be installed in an array to create a secure area according to security and project requirements.

Bollard Construction:

The bollards shall be 10.75” diameter. Bollard Height is 39.4” the bollards shall be constructed of heavy gauge steel fully welded prior to priming & painting or optional hot dip galvanizing. Galvanizing shall comply with ASTM 123 specifications.

Installation:
A scan should be performed prior to excavation to make sure the installation site is free of any obstacles. ASP DS22 Bollards shall be installed according to manufacturer’s supplied installation/foundation drawings.

Performance:
ASP DS 22 Fixed and removable bollards shall perform to K12 performance specifications as defined by US department of State.

Experience:

The bollard system shall be based on the Department of State design and meet K12 or M50/P1 requirements. The manufacturer shall be a company specializing in the supply of vehicle barrier systems with a minimum of 10 years’ experience in the manufacturing of such systems.

Accreditation:

The bollard system (Bollard tubes and foundations) have been designed to the K12 performance (15000lbs at 50mph) High Energy Attack listed in USDOS Standard SD-STD-02.01 and be listed on the US Department of State list of acceptable barriers.

The bollard(s) by accreditation are capable of stopping and immobilising vehicles with weight and velocity characteristics as described above. The bollard(s) are designed to destroy the front suspension, steering linkage and engine casing.

The bollard(s) system is designed to stop a vehicle attacking, with weight and velocity characteristics as described above, from either direction.

3.0 Quality Assurance

Testing/Quality assurance:

Upon completion of the system build the bollard system will be fully quality checked at the manufactures facility.

Shipment:

ASP DS 22 bollards will packaged in a sufficient manner for transport domestically so that the risk to damage is minimal. Export shipments can be crated and be of sufficient structural integrity to be lifted and transported by overhead crane or forklift truck without failure.

Warranty:

ASP DS 22 fixed and removable bollards are warranted against defects in material and workmanship for a period of the lesser of 1 year from the date of substantial completion, or 1.5 years from the date of shipment. See Ameristar Security Products website for full warranty details

Servicing & System Care:

All parts are able to be replaced with Ameristar fitted parts. If any other manufacturer parts are fitted to the unit, this will invalidate the year warranty.

If the site which the bollards are installed within becomes the property of a third party after the initial sale – the site must be re-registered with Ameristar for the warranty to be valid.

Drawings & Installation Data:

Installation instructions and site specific layout drawings can be provided by the manufacturer upon request.
A full operation and maintenance manual will be issued on handover of the system.

Disclaimer:

This type of equipment is designed for security use and while it is possible to integrate a number of safety features into the system design, it is generally better to provide adequate traffic calming measures, signage, area illumination and traffic lights to warn users of the potential hazards.

Ameristar can provide information on safety systems to suit most sites/ applications on request.

It is strongly recommended that advice is taken from relevant security or safety engineers with regard to the system design, alternatively Ameristar would be pleased to provide such information- contact Sales department at our Tulsa office.

Procurement Details:

Bollards shall be purchased from:

Ameristar Security Products
1555 N Mingo Road,
Tulsa, OK 74134
Ph: 888-333-3422 Fax: 877-926-3747
www.ameristarsecurity.com

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