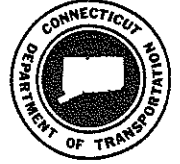




STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION



2800 BERLIN TURNPIKE, P.O. BOX 317546
NEWINGTON, CONNECTICUT 06131-7546

Phone:
(860) 594-3129

Subject: Project No. 300-139
New Haven: Independent Wheel True Facility – New
Haven Rail Yard.

March 15, 2011

NOTICE TO CONTRACTORS:

This is to notify all concerned and especially the prospective bidders that the bid opening for the subject project has been previously postponed to April 6, 2011 at 2:00 P.M. in the Conference Room of the Department of Transportation Administration Building, 2800 Berlin Turnpike, Newington, Connecticut.

In addition to the Contracting Portal (http://www.biznet.ct.gov/scp_search/BidResults.aspx?groupid=64) the Department now has an FTP site which Contractors should utilize to access Project Information. Please refer to the instructions below, disseminate to the proper personnel and share with anyone having a need to know. In addition, the Department has established a general mailbox to receive contractor questions. Please send all future questions to DOTContracts@ct.gov.

Addendum No. 2 is available online via the FTP Site

This addendum is necessary to revise Special Provisions and Contract Items, and to add and revise Plan Sheets.

Revised Bid Proposal Forms are being issued to prospective bidders by US Postal Service Priority Mail.

The FTP site for Contractors to access Project Information:

Location: <https://sfile.ct.gov/>

Logon: CTDOTContract

Password: ctdotBid123

Gregory D. Straka
Contracts Manager
Division of Contracts Administration

MARCH 15, 2011
NEW HAVEN RAIL YARD FACILITIES IMPROVEMENTS:

INDEPENDENT WHEEL TRUE FACILITY

STATE PROJECT NO. 300-139
CITY OF NEW HAVEN

ADDENDUM NO. 2

SPECIAL PROVISIONS

REVISED SPECIAL PROVISIONS

The following Special Provisions are hereby deleted in their entirety and replaced with the attached like-named Special Provisions:

- **NOTICE TO CONTRACTOR – METRO-NORTH RAILROAD SUBMITTALS**
- **ITEM NO. 0001130A – 500 KCMIL, 15 KV SHIELDED COPPER CABLE**

REVISED CSI SPECIAL PROVISIONS

The following CSI Special Provisions are hereby deleted in their entirety and replaced with the attached like-named Special Provisions:

- **SECTION 21 05 00 – COMMON WORK RESULTS FOR FIRE SUPPRESSION**
- **SECTION 22 05 29 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**
- **23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**
- **SECTION 26 05 13 – MEDIUM-VOLTAGE CABLES**
- **SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**
- **SECTION 26 12 00 – MEDIUM-VOLTAGE CABLES**
- **SECTION 26 13 00 – MEDIUM-VOLTAGE SWITCHGEAR**
- **SECTION 27 05 00 – COMMON WORK RESULTS FOR COMMUNICATIONS**

CONTRACT ITEMS

REVISED CONTRACT ITEMS

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>ORIGINAL QUANTITY</u>	<u>REVISED QUANTITY</u>
<u>0213013</u>	<u>GRANULAR FILL</u>	<u>3,400 CY</u>	<u>3,100 CY</u>
<u>0601365A</u>	<u>CONCRETE PAD</u>	<u>80 CY</u>	<u>90 CY</u>
<u>0901003A</u>	<u>STEEL BOLLARD</u>	<u>137 EA</u>	<u>141 EA</u>

PLANS

NEW PLANS

The following Plan Sheets are hereby added to the Contract:

007-1

042-2

REVISED PLANS

The following Plan Sheets are hereby deleted and replaced with the like-numbered Plan Sheets:

015, 016, 027, 033, 035, 037, 041, 076, 080, 086, 090, 112, 120, 196, 236, 237, 257, 299,
313

The Bid Proposal Form has been revised to reflect these changes.

There will be no change in the number of calendar days due to this Addendum.

The foregoing is hereby made a part of the contract.

NOTICE TO CONTRACTOR – METRO-NORTH RAILROAD SUBMITTALS

The submittals associated with the specifications listed below, that require Metro-North Railroad review for conformance with the Contract, shall be clearly labeled “Requires Metro-North Review” on the transmittal when submitted electronically. Hard copies of all final approved submittals shall be hand delivered or sent by mail directly to Metro-North Railroad, 50 Union Avenue, 2nd Floor (West), New Haven, CT 06519, Attention: Mr. Jay Patel. Review of the following submittals may take up to 60 days in accordance with Form 816 Article 1.20-1.05.02. The Contractor shall bid the project accordingly.

Special Provisions

1. ITEM #0000523A - 600 V COPPER WIRE NO. 500 KCMIL
ITEM #0000641A - 600 V COPPER WIRE NO. 250 KCMIL
ITEM #1012180A – BARE COPPER WIRE NO. 4/0 AWG
2. ITEM #0000591A - 3” PVC DUCT BANKS – 2 DUCTS
ITEM #0000580A – 4” PVC DUCT BANKS – 1 DUCT
ITEM #0000581A – 4” PVC DUCT BANKS – 2 DUCTS
ITEM #0000582A – 4” PVC DUCT BANKS – 4 DUCTS
ITEM #0000349A – 4” PVC DUCT BANKS – 8 DUCTS
ITEM #0000354A – 4” PVC DUCT BANKS – 12 DUCTS
ITEM #0000546A – 5” P.V.C. DUCT BANKS - 4 DUCTS
ITEM #0000547A – 5” P.V.C. DUCT BANKS – 6 DUCTS
ITEM #0000426A – ELECTRIC HANDHOLE
ITEM #1010912A – ELECTRIC MANHOLE
ITEM #1010916A – CONCRETE MANHOLE
3. ITEM #0001130A – 500 KCMIL, 15 KV, SHIELDED COPPER CABLE
4. ITEM #0090042A – CATENARY SYSTEMS
ITEM #0090045A - AERIAL GROUND WIRE SYSTEMS
5. ITEM #0090050A - HIGH SPEED SECTION INSULATORS
6. ITEM #0090075A - GUY ASSEMBLIES
7. ITEM #0090076A - MODIFICATIONS & ADDITIONS TO EXISTING CATENARY SYSTEMS
8. ITEM #1003508A – HIGH MAST LIGHT POLE (100’)
9. ITEM #1015012A – BARE COPPER GROUNDING CONDUCTOR (#4/0)

CSI-Formatted Specifications

10. CSI SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES
11. CSI SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
12. CSI SECTION 26 12 00 - MEDIUM-VOLTAGE TRANSFORMERS
13. CSI SECTION 26 13 00 - MEDIUM-VOLTAGE SWITCHGEAR

14. CSI SECTION 26 24 16 - PANELBOARDS
15. CSI SECTION 26 32 13 - ENGINE GENERATORS
16. CSI SECTION 26 33 53 - STATIC UNINTERRUPTIBLE POWER SUPPLY
17. CSI SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS
18. CSI SECTION 27 53 20 - BLUE LIGHT CCTV SURVEILLANCE
19. CSI SECTION 27 53 30 - BLUE LIGHT SYSTEM
20. CSI SECTION 27 53 31 - BLUE LIGHT SYSTEM SIGNAL EQUIPMENT
21. CSI SECTION 28 13 00 - ACCESS CONTROL

Operation and Maintenance Manuals:

22. All Operation and Maintenance Manuals listed in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

ITEM #0001130A - 500 KCMIL, 15 KV SHIELDED COPPER CABLE

Description:

Scope

This Section includes cables and related splices, terminations, and accessories for 15 KV shielded copper cable electrical distribution systems.

Quality Assurance

- A. Cable Manufacturers' Qualification: Not less than fifteen (15) years experience in the actual production of the specified products.
- B. Workmanship shall conform to the best modern practices in the manufacturing of a rugged, durable, and safe product for use in a public transportation system. Materials used shall be new and of the highest commercial grade as specified.
- C. The Insulated Cable shall be manufactured and tested under the control of a Quality Assurance system that conforms to the requirements of ISO 9000.
- D. The Quality Assurance system shall demonstrate conformance to the above criteria by having passed yearly quality audits conducted by outside independent organizations.

Submittals

The Contractor shall submit the following for review and approval of the designer at various stages of planning, manufacturing, and installation of cable and wire as requested:

- A. Descriptive literature, catalog data, and other pertinent information for cable splices sufficient to clearly demonstrate compliance with the Contract Documents.
- B. Cable pulling plan showing cable feed and pulling winch locations, cable lengths, and calculated pulling tensions for each cable pull over 200 feet in length, or with a total of 180° or more of conduit bends.
- C. Proposed cable lubricants and associated lubricating devices.
- D. Proposed cable pulling equipment including cable grips, pulling rope, tensiometers, swivels, and cable pullers (winches).
- E. Qualifications of all cable splicers proposed to be utilized for splicing work.

- F. As-built lengths of all cable installed under this Contract.
- G. Product Data: Shall consist of manufacturer's standard catalog cuts, descriptive literature and diagrams, in 8½ X 11-inch format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and standards.
- H. Manufacturer's Certification: Manufacturer shall submit signed certification confirming that they comply with the qualifications requirements and shall provide evidence of experience upon request.
- I. Product Certification: Signed by manufacturer certifying that products comply with the specified specification requirements.
- J. Report of Field Tests: Certified copies of field tests.
- K. 24-inch long samples of the final assembled cables for First Article Inspection prior to release.
- L. Submit catalog cuts for the following:
 - 1. Wires and cables for each type and size.
 - 2. Splice kit materials and installation procedures.
- M. Submit certified shop test reports for wires and cables.
- N. Submit field test results for wires and cables, including megger readings with the method used.

Materials:

Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

Cable type shall be MV105, and shall comply with UL 1072, AEIC CS 8, ICEA S-93-639, ICEA S-97-682 and ICEA S-94-649. Conductor will be copper, and the conductor stranding will be compact round, concentric lay, Class B with the conductor strand interstices filled with impermeable compound. Conductor insulation will be ethylene-propylene rubber with a voltage rating of 15 kV and an insulation thickness of 133 percent of the insulation level. Cable shielding will be copper tape helically applied over semiconducting insulation shield. The cable jacket will be sunlight-resistant PVC. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Cables:

- A. Okonite Company (The).
- B. Kerite Co. (The); Hubbell Incorporated.
- C. Pirelli Cables & Systems NA
- D. Southwire.
- E. Or approved equal.

Connectors and Splice Kits shall comply with IEEE 404 with the type as recommended by the cable or splicing kit manufacturer for the application. Splicing Products will be as recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions. Splices shall be suitable for submersible applications.

1. In-Line Splices shall be heat-shrink splicing kit of uniform cross-section, polymeric construction with outer heat-shrink jacket that covers the entire splice. The grounding mesh shall be internal to the outer jacket. Connectors shall be compression type.

Solid terminations for shielded cables shall comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations be one of the following:

1. Class I Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class I Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class I Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Cable Splicing Products and Accessories:

- A. Thomas & Betts Corporation/Elastimold, Part No. 655LR and K655LR power distribution connectors.
- B. Tyco/Ray-Chem
- C. Or approved equal.

600-A dead break connectors, "hammerhead style," with no test point shall be used for 15 KV high voltage splices in manholes. 600-A dead break connectors shall be supplied by Tyco/Ray-Chem or approved equal. Separable insulated connectors shall comply with IEEE 386.

Provide tool set consisting of shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

Tape for first course on metal objects will be 1 G-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape. Arc-Proofing Tape to be used is fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket. Glass-cloth tape will be pressure-sensitive adhesive type, 1/2 inch wide.

Fault indicators are automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

Test and inspect cables according to ICEA S-97-682, ICEA S-94-649 before shipping. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig. Obtain cables and accessories through one source from a single manufacturer.

Construction Methods:

Install cables according to IEEE 576.

Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable. Before pulling cables in existing conduits, the Contractor shall review the conduit run via camera to verify that the conduit does not contain obstructions that could damage the cables. Obstructions shall be removed by thorough cleaning and then testing by the successful pulling of a brush and mandrel approved by the Engineer. The mandrel shall be not less than 1/4 inch smaller than the inside nominal diameter of the conduit. The Contractor shall give the Engineer 24 hours notice prior to witness the cleaning and testing.

Install direct-buried cables on leveled and tamped bed of 3 inch thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices. Install "buried-cable" warning tape 12 inches above cables.

In manholes, handholes pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

Install cable splices at pull points and elsewhere as indicated; use standard kits. Install terminations at ends of conductors and seal cable ends with standard kits.

Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: Three.
3. Standoff Insulator: Three.

Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable. Band arc-proofing tape with 1-inch wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.

Seal around cables passing through fire-rated elements with penetration Firestopping.

Install fault indicators on each phase where indicated.

Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

Identify cables according to NFPA 70 and ANSI A13.1 "Identification for Electrical Systems."

Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports: Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

Remove and replace malfunctioning units and retest as specified above.

Method of Measurement:

The work covered by this section will be measured on a per "linear foot" basis, completely installed, including but not limited to materials, equipment, and labor for the installation, splicing, terminations and testing of the 15 KV Shielded Copper Cables.

Basis of Payment:

This work will be paid for at the contract unit price each for “500 KCMIL, 15 KV, Shielded Copper Cable.”

Pay Item

Pay Unit

500 KCMIL, 15 KV Shielded Copper Cable

L.F.

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Concrete bases.
7. Supports and anchorages.
8. Under slab pipe support

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. 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.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR - SUBMITTALS.
- B. Welding certificates.
- C. Quality Assurance Submittals:

1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR - POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.
2. Source quality-control test reports.
3. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

- 1.5 Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 WARRANTY

- A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, 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 Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12.

2.3 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.5 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, stamped chrome-plated finish.

- C. One-Piece, floor plate.
 - 1. Finish: Polished chrome-plated and rough brass.

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.

- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- S. Under slab pipe supports shall be configured and spaced as per details in the Structural Drawings.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.5 GROUTING

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.

- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout in compliance with manufacturer's written instructions.

END OF SECTION 21 05 00

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.
 - 9. Under slab piping supports.

- B. Related Sections include the following:
 - 1. Division 05 Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 22 Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
 - 3. Division 22 Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Pipe positioning systems.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.
- D. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel" and ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 3. ASME Boiler and Pressure Vessel Code: Section IX.

1.6 WARRANTY

- A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to manufactures specified:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Bergen-Power Pipe Supports.
 - 3. B-Line Systems, Inc.; a division of Cooper Industries.
 - 4. Carpenter & Paterson, Inc.
 - 5. Empire Industries, Inc.
 - 6. ERICO/Michigan Hanger Co.
 - 7. Globe Pipe Hanger Products, Inc.
 - 8. Grinnell Corp.
 - 9. GS Metals Corp.
 - 10. National Pipe Hanger Corporation.
 - 11. PHD Manufacturing, Inc.
 - 12. PHS Industries, Inc.
 - 13. Piping Technology & Products, Inc.
 - 14. Tolco Inc.
 - 15. Or approved equal.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to manufactures specified:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
 - 8. Or approved equal.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to manufactures specified:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
 - 7. Or approved equal.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to manufactures specified:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Or approved equal.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to manufactures specified:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.
 - 4. Or approved equal.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- B. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use padded hangers for piping that is subject to scratching.
- E. Horizontal-Piping Hangers and Supports: Install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 16. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

17. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
18. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
19. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
20. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

F. Vertical-Piping Clamps: Install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

G. Hanger-Rod Attachments: Install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

H. Building Attachments: Install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- I. Saddles and Shields: Install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- J. Spring Hangers and Supports: Install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 3. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 4. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 5. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 6. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- N. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick 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.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so piping live and dead loads 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 maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- O. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - 5. Insert Material: Length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- P. Under slab piping supports shall be configured and spaced as per details in the Structural Drawings.

3.3 EQUIPMENT SUPPORTS

- A. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers 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 shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with 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 no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: 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.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 22 05 29

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
 - 7. Under slab conduit and piping supports.
- B. See Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- C. See Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
- D. See Section 23 31 13 "Metal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- B. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.

- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Equipment supports.

- D. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

1.6 WARRANTY

- A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 1. AAA Technology & Specialties Co., Inc.
 2. Bergen-Power Pipe Supports.
 3. B-Line Systems, Inc.; a division of Cooper Industries.
 4. Carpenter & Paterson, Inc.
 5. Empire Industries, Inc.
 6. ERICO/Michigan Hanger Co.
 7. Globe Pipe Hanger Products, Inc.
 8. Grinnell Corp.
 9. GS Metals Corp.
 10. National Pipe Hanger Corporation.
 11. PHD Manufacturing, Inc.
 12. PHS Industries, Inc.
 13. Piping Technology & Products, Inc.
 14. Tolco Inc.
 15. Or approved equal.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.
8. Or approved equal.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.
7. Or approved equal.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

- a. Hilti, Inc.
- b. ITW Ramset/Red Head.
- c. Masterset Fastening Systems, Inc.
- d. MKT Fastening, LLC.
- e. Powers Fasteners.
- f. Or approved equal.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Empire Industries, Inc.
- c. Hilti, Inc.
- d. ITW Ramset/Red Head.
- e. MKT Fastening, LLC.
- f. Powers Fasteners.
- g. Or approved equal.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

- 1. Properties: Nonstaining, noncorrosive, and nongaseous.
- 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

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

- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.

7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

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

- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

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

- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

- E. Fastener System Installation:
 - 1. Install powder-actuated 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.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

- I. Install lateral bracing with pipe hangers and supports to prevent swaying.

- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- N. Under slab conduit and piping supports shall be configured and spaced as per details in the Structural Drawings.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers 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 shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with 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 no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

3.6 PAINTING

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

END OF SECTION 23 05 29

SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems, 15kV underground primary distribution cable, jacketed.

1.2 DEFINITIONS

- A. ATS: Acceptance Testing Specification.
- B. NETA: InterNational Electrical Testing Association, Inc.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of cable indicated. Information to include size, type and class, materials (insulation, shielding, and jacketing), number of and diameter of individual wires, overall diameter, cross section area, weight per foot, maximum pulling tension, minimum bending radius for pulling and training, maximum sidewall pressure, and include splices and terminations for cables and cable accessories.
- C. Samples: 16-inch lengths of each type of cable being proposed to be used.
- D. Qualification Data: For installer.
- E. Material Certificates: For each cable and accessory type, signed by manufacturers.
- F. Source quality-control test reports.
- G. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association (NETA) or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.
- D. ICEA S-68-516: Ethylene-Propylene-Rubber Insulated Wire and Cable for Transmission and Distribution of Electrical Energy.
- E. ASTM B-8: Concentric-Lay-Stranded Copper Conductors.
- F. UL 1072: Medium-Voltage (Type MV) Solid-Dielectric.
- G. AEIC CS6: Specification for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV.
- H. NEMA WC26: Wire and Cable Packaging.
- I. Comply with IEEE C2 and NFPA 70.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Department or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify The Department no fewer than fourteen (14) days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without The Department's written permission.

1.6 WARRANTY

- A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cables:
 - a. Okonite Company (The).
 - b. Kerite Co. (The); Hubbell Incorporated.
 - c. Pirelli Cables & Systems NA.
 - d. Southwire.
 - e. Or approved equal.
 - 2. Cable Splicing and Terminating Products and Accessories:
 - a. Thomas & Betts Corporation/Elastimold.
 - b. Tyco/RayChem
 - c. Or approved equal.

2.2 CABLES

- A. Cable Type: MV105, 15kV, 133 percent insulation level for the 13.8kV, 60HZ power distribution system.
- B. Conductor Insulation: Ethylene-propylene rubber (EPR) insulated cable conforming to ICEA S-93-639/NEMA WC 74.
 - 1. Voltage Rating: 15kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- C. Conductor: Single Conductor, #2 (or as indicated), Copper.
- D. Conductor Stranding: Concentric lay, Class B.
- E. Strand Filling: Conductor interstices are filled with impermeable compound.
- F. Shielding: Copper taped, helically applied over semi-conducting insulation shield.
- G. Jacket: Extra heavy duty, flame retardant, sun light resistant PVC.

2.3 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. In-Line Splices shall be heat-shrink splicing kit of uniform cross-section, polymeric construction with outer heat-shrink jacket that covers the entire splice. The grounding mesh shall be internal to the outer jacket. Connectors shall be compression type. Solid terminations for shielded cables shall comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations to be one of the following:
 - a. Class I Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
 - b. Class I Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 - c. Class I Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.

- 2.4 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. Thomas & Betts Corporation/Elastimold, Part No. 655LR and K655LR power distribution connector.
 - b. Tyco/RayChem
 - c. Or approved equal.

- 2.5 600A dead break connectors, "hammerhead style," with no test point shall be used for 15 KV high voltage splices in manholes. 600-A dead break connectors shall be supplied by Tyco/RayChem or approved equal. Separable insulated connectors shall comply with IEEE 386. Provide tool set consisting of shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case. Tape, for first course on metal objects will be 1 G-mil-(250-micromcter-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape. Arc-Proofing Tape to be used is fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket. Glass-cloth tape will be pressure-sensitive adhesive type, 1/2 inch wide. Fault indicators are automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions. Test and inspect cables according to ICEA S-97-682, ICEA S-94-649 before shipping. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig. Obtain cables and accessories through one source from a single manufacturer.

2.6 CABLE SUPPORTS

- A. Cable racks in Manholes, Handholes and Pull Boxes:

1. Cable racks shall be wall mounted type supported by concrete embedded mounting bolts installed in the field. The mounting bolts shall be stainless steel, 1/2 inch diameter minimum.
2. The exact locations and quantities of cable racks depend upon the exact locations of the ductbank knockouts in each style of manhole and pull box, and shall be subject to approval by the Designer.
3. Cable racks shall be made from hot rolled steel channel, hot-dipped galvanized. Cable rack hook shall be formed of hot-dipped galvanized steel, with smooth surfaces (porcelain saddles), to protect the cables from damage.
4. Cable rack hooks shall fit into the rack slots and have turned up ends to prevent the cable from slipping off.
5. A No. 2 AWG bare copper conductor shall be bonded to each rack and then connected to the manhole ground.

2.7 REELS AND PACKING

- A. The cables shall be packaged, furnished and shipped on returnable reels in accordance with NEMA WC 26. Reels shall be constructed of materials that shall provide proper protection to the cable during shipment and handling.
- B. A watertight seal shall be applied to each end of the cable to prevent the entrance of moisture during transit or exterior storage.
- C. A durable label shall be securely attached to each flange of each reel. Each label shall indicate the purchase order number, name of manufacturer, reel number, length of cable on reel, description of cable, weight of reel, rolling direction, and source of manufacturer.

2.8 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, and intumescent to 0.3 inch thick, compatible with cable jacket.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.

2.9 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-93-639 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.

- B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
- C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- D. Support cables according to Division 26 Section 26 05 29 "Hangers and Supports for Electrical Systems".
- E. Install "buried-cable" warning tape 12 inches above duct banks.
- F. In manholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- G. Install cable splices at pull points and elsewhere as indicated.
- H. Cables in manholes shall be joined (spliced) by way of dead-break elbows on applicable conductors, mated with appropriate dead-front terminal junctions. Install separable insulated connector components as follows:
 - 1. Protective Cap: At each dead-front terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - 2. Portable Feed-Through Accessory: Three.
 - 3. Standoff Insulator: Three.

Splice kits shall be utilized only if conditions indicate that elbow/terminal junctions are not feasible.
- I. All cables entering/leaving pad-mounted switchgear shall utilize solid, shielded cable terminations.
- J. Arc-Proofing: Unless otherwise indicated, arc-proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc-proofing as follows:
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with coated side towards cable.
 - 5. Band arc-proofing tape with 1-inch wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.
- K. Seal around cables passing through fire-rated elements according to Division 07 Section 07 84 00 "Firestopping".

- L. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- M. Identify cables according to Division 26 section 26 05 53 “Identification for Electrical Systems”.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test medium voltage cables in accordance with Form 816 Article 1.20-1.05.10 and as follows:
- B. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 13

SECTION 26 05 29 - 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.
3. Under slab conduit supports.

B. Related Sections include the following:

1. Division 26 Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria, see Structural Documents for specific criteria in each building section.

1.2 DEFINITIONS

A. RMC: Rigid metal conduit; also known as RGS conduit.

B. EMT: Electrical Metallic Tubing conduit.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this each section of this Project, with a minimum structural safety factor of two (2) times the applied force in most building sections with five (5) times the applied force in structurally defined seismic locations.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- B. Product Data: For the following:
 - 1. Steel slotted support systems.

- C. Shop Drawings: Show fabrication and installation details for the structurally defined seismic locations that include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of hangers and supports or electrical systems.

- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section 07 72 00 "Roof Accessories."

1.7 WARRANTY

- A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS for additional information.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Thomas & Betts Corporation.
 - c. Unistrut; Tyco International, Ltd.
 - d. Or approved equal.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Channel Dimensions: Selected for applicable load criteria or as indicated on the Contract Documents, whichever is the stronger of the two.
- 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. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Or approved equal.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Hilti Inc.
 - 3) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 4) Or approved equal.
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 05 Section 05 50 00 "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 RMC and EMT as shown on the Contract Plans and as required in NFPA 70. Minimum rod size shall be 1/2 inch in 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 20 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

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, 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 previously poured Concrete: Expansion anchor fasteners or epoxy anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete, pre-cast concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69].
 - 7. To Light Steel: Sheet metal screws.
 - 8. 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 seismic-restraint strength and anchorage requirements.
- E. Drill holes for anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Under slab conduit supports shall be configured and spaced as per details in the Structural Drawings.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section 05 50 00 "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 inches larger 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 03 Section 03 30 00 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting plans, 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: Comply with requirements in Division 09 Section 09 91 00 "Painting" for 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.

END OF SECTION 26 05 29

SECTION 26 12 00 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of transformers with medium-voltage primaries:
 - 1. Pad-mounted, liquid-filled transformers.

1.2 DEFINITIONS

- A. ATS: Acceptance Testing Specification.
- B. NETA: InterNational Electrical Testing Association, Inc.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
- C. Shop Drawings: Diagram power wiring.
- D. Coordination Plans: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Underground primary and secondary conduit stub-up location.
 - 2. Dimensioned concrete base, outline of transformer, and required clearances.
 - 3. Ground rod and grounding cable locations.
- E. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems".

Include the following:

- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Plans of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Qualification Data: For testing agency.

G. Source quality-control test reports.

H. Field quality-control test reports.

I. Follow-up service reports.

J. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Product Options: Plans indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated.

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 IEEE C2.

E. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.

F. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store transformers so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.6 PROJECT CONDITIONS

- A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
 - 1. Exposure to hot and humid climate.
 - 2. Exposure to seismic shock.
 - 3. Exposure to excessively high or low temperatures.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.
- C. Coordinate with Metro North Railroad prior to energization.

1.8 WARRANTY

- A. Refer to Form 816 Article 120-1.06.08 and NOTICE TO CONTRACTOR- CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Industries, Cooper Power Systems Division.
 - 2. Cutler-Hammer.
 - 3. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
 - 4. GE Electrical Distribution & Control.
 - 5. Siemens Energy & Automation, Inc.
 - 6. Square D; Schneider Electric.
 - 7. Virginia Transformer Corp.
 - 8. Or approved equal.

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

- A. Description: ANSI C57.12.13, ANSI C57.12.26, pad-mounted, 2-winding transformers. Stainless-steel tank base and sills.
- B. Coils: Continuous copper windings without splices except for taps.
- C. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.

- D. Insulation Class and Winding Temperature Rise: 120 C Insulation temperature, with 65 deg C Winding temperature when operated at rated kVA output in a 30 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
- E. Basic Impulse Level: 95 kV.
- F. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- G. High-Voltage Terminations and Equipment: The molded rubber terminator must be made from silicone rubber. Also, shall be a one-piece cold shrink exterior type terminator according to Standard IEEE 48-1990, for Class 1 terminations.
- H. Accessories:
 - 1. Drain Valve: 1 inch, with sampling device.
 - 2. Dial-type thermometer.
 - 3. Liquid-level gage.
 - 4. Pressure-vacuum gage.
 - 5. Pressure Relief Device: Self-sealing with an indicator.
 - 6. Mounting provisions for low-voltage current transformers.
 - 7. Mounting provisions for low-voltage potential transformers.

2.3 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 26 05 53 "Identification for Electrical Systems."

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90 and IEEE C57.12.91.
- B. Factory Tests: Perform the following factory-certified tests on each transformer:
 - 1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
 - 2. Ratios on rated-voltage connection and on tap extreme connections.
 - 3. Polarity and phase relation on rated-voltage connection.
 - 4. No-load loss at rated voltage on rated-voltage connection.
 - 5. Excitation current at rated voltage on rated-voltage connection.
 - 6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
 - 7. Applied potential.
 - 8. Induced potential.

9. Department will witness all required factory tests. Notify The Department at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line connections.
- C. Examine concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and that requirements in Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on concrete bases.
 1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section 26 05 29 "Hangers and Supports for Electrical Systems."
 2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting plans, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section 26 05 53 "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections in accordance with Form 816 Article 1.20-1.05.10 and as follows:
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
 - 1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
 - 2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Test Reports: Prepare written reports to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: If requested by Department, perform the following voltage monitoring after issuance of Certificate of Compliance but not more than six months after issuance of Certificate of Compliance:
 - 1. During a period of normal load cycles as evaluated by Department, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
 - a. Adjust transformer taps.
 - b. Prepare written request for voltage adjustment by electric utility.
 3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
 4. Report: Prepare written report covering monitoring and corrective actions performed.
- B. Infrared Scanning: Perform as specified in Division 26 Section 26 13 00 "Medium-Voltage Switchgear."

END OF SECTION 26 12 00

SECTION 26 13 00 – MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes metal-enclosed, air-insulated, pad-mounted, switchgear arranged as shown on the plans, complete with the following components, features, and accessories:
 - 1. Three pole, gang-operated, load interrupting switch ways.
 - 2. Fused ways.
 - 3. Surge arresters.
- B. Requirements for furnishing, installing, connecting and testing outdoor medium voltage (15kV) load break disconnect switch.
- C. The disconnect switch shall be free-standing, metal-clad and shall comply with Utility requirements.
- D. This section covers the requirements for an assembled 15kV switchgear arrangement as shown on the Contract Drawings.

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of switchgear and related equipment, include the following:
 - 1. Rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Time-current characteristic curves for overcurrent protective devices.
- C. Shop Drawings: For each type of switchgear and related equipment, include the following:
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
 - d. Floor plan drawing showing locations for anchor bolts.
 - e. Ampere ratings of buses.
 - f. Short-time and short-circuit ratings of switchgear assembly.
 - g. Nameplate legends.

2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.
3. Wiring Diagrams: For each type of switchgear and related equipment, include the following:
 - a. Power, signal, and control wiring.
 - b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
 - c. Schematic control diagrams.
 - d. Diagrams showing connections of component devices and equipment.
 - e. Schematic diagrams showing connections to remote devices.
- D. Coordination Plans: Floor plans showing dimensioned layout and required working clearances. Show switchgear layout and relationships between components and adjacent structural elements. Identify field measurements.
- E. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, accessories, and components will withstand seismic forces defined in Division 26 Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 2. Dimensioned Outline Plans of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Source quality-control test reports.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.
- D. Product Options: Plans indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated.
- E. 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.
- F. Comply with IEEE C2.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.
- B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.
- D. Where necessary, brace disconnect switch for hoisting, lowering and skidding into position. Label temporary internal bracing of disconnect switch: "TEMPORARY - REMOVE BEFORE OPERATION".
- E. Design enclosures or packaging to permit lifting of jacks or slings and moving horizontally on rollers or skidding in any direction. Provide handling instructions.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 1. Ambient temperature not exceeding 104 deg F.
 2. Altitude of 75 feet above sea level.
- B. Product Selection for Restricted Space: Plans indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

- C. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Department or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify The Department no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Designer's written permission.
 3. Indicate method of providing temporary electrical service.

1.6 COORDINATION

- A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- C. Coordination with Metro North Railroad prior to energizing any equipment.

1.7 WARRANTY

- A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.8 SPARE PARTS

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Touchup Paint: Three containers of paint matching enclosure finish, each 0.5 pint, for each pad mounted unit.
- B. Maintenance Tools: Furnish tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation.
 1. Six power fuse refill units, or, power fuse units, for each pad-mounted unit.

1.9 REFERENCE STANDARDS

- A. The latest edition of the publications listed in each section form a part of these Specifications to the extent referenced. The publications are referred in the text by basic designation only. In the case of conflict between provisions of codes, laws, ordinances, and these specifications, including the Contract Drawings, the more stringent requirements, as determined by the Engineer, shall apply.
- B. American National Standards Institute (ANSI):

C2	National Electrical Safety Code
C37.20.3	Metal-Enclosed Interrupter Switchgear
C37.20.4	AC Medium Voltage Switches For Use in Metal-Enclosed

Switchgear

ANSI/IEEE
C37.22 American National Standard for Preferred Ratings and Related Required Capabilities for Indoor AC Medium Voltage Switches Used in Metal-Enclosed Switchgear

ANSI/IEEE
C37.57 American National Standard for Switchgear – Metal-Enclosed Interrupter Switchgear Assemblies – Conformance Testing

ANSI/IEEE
C37.58 American National Standard for Switchgear – Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear – Conformance Test Procedures

C. National Fire Protection Association (NFPA):

70 National Electrical Code

D. National Electrical Manufacturers Association (NEMA):

SG5 Power Switchgear Assemblies

E. The following information shall be submitted to the Engineer. All drawings shall be prepared in accordance with current industry practice and all information shall be in the English language, clearly readable, with IEEE, ANSI, and NEMA symbols, device numbers, etc.

1. Master drawing index.
2. Front view elevation.
3. Floor plan.
4. Single line diagram.
5. Schematic diagrams.
6. Nameplate diagram.
7. Component list.
8. Conduit and bus duct entry/exit locations.
9. Cable terminal sizes.
10. Weight.
11. Busway connection.
12. Recommended torque values.
13. Equipment anchorage details.
14. Connection details between close-coupled assemblies.
15. Key interlock scheme drawing and sequence of operations.
16. Installation manuals.
17. Descriptive bulletins.
18. Product sheets.
19. Ratings including:
 - a. Maximum voltage.
 - b. Continuous current.
 - c. Maximum short circuit current.
 - d. Fault closing.
 - e. Basic impulse level.
 - f. Operating frequency.

1.10 QUALIFICATIONS

- A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years.
- B. A reference list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.11 CERTIFICATION

- A. All load interrupter switches and accessories shall be UL-listed and bear the UL label.

1.12 FACTORY TESTS

- A. Submit certified copies of design test reports for load break disconnect switches as assembled as a complete unit.
- B. Switchgear Assembly Tests: Perform production tests in accordance with ANSI C37.20.2.

PART 2 - PRODUCTS

2.1 METAL-ENCLOSED AIR INSULATED PAD-MOUNTED SWITCHGEAR

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work, include, but are not limited to, the following:
 - 1. S&C Electric Company.
 - 2. G&W Electric Company.
 - 3. Eaton Company.
 - 4. Or approved equal.

2.2 MEDIUM VOLTAGE LOAD BREAK DISCONNECT SWITCH

- A. General: Provide a single section non-walk-in outdoor disconnect switch as described herein and as shown on the Contract Drawings. The equipment shall conform to applicable NEMA, ANSI and IEEE standards.
- B. The disconnect switch shall be electrically operated three pole, rated as shown on the Contract Documents.
- C. The completed metal enclosed disconnect switch shall have the following electrical ratings:
 - 1. Maximum Design Voltage: 15 kV.
 - 2. Nominal Voltage: 13.8 kV.
 - 3. System Voltage: 13.2 kV, 3 phase, 3 wire, 60Hz.
 - 4. Lightning Impulse Withstand (BIL): 95 kV.
 - 5. Power Frequency, 1 minute Withstand: 36 kV.
 - 6. Continuous Amperes: 600A.

7. Momentary Current: 40,000A rms.
8. Fault Close Current: 40,000A rms.
9. Interrupting Rating: 600A symmetrical.
10. Short Time Current 2-Sec: 25,000A rms.
11. Load Current Switching Amperes: 600A.

D. Construction: The load break disconnect switch shall be a separately constructed cubicle assembled to form a rigid, free-standing unit. Adjacent transition sections shall be securely bolted together to form an integrated rigid structure. To assist installation and maintenance of bus and cables the rear covers shall be removable. Brace each individual unit to prevent distortion. Unit shall be suitable for bottom entry cables.

1. Provision shall allow for convenient extension of both the main bus and the ground bus to adjacent unit. Furnish and support the main bus on porcelain insulators. Run the ground bus continuously through the entire line-up and securely connect to the steel frame.
2. Design outdoor unit with a sloped drip proof roof. The cubicle must have an outer door over the inner door. The non-walk-in disconnect shall consist of load break fusible disconnect switch located in a steel housing of non-walk-in weatherproof construction, equipped with a hinged front door with a provision for padlocking. Auxiliary cell is also equipped with an inner hinged front door for mounting auxiliaries.
3. Furnish the following equipment:
 - a. One lamp receptacle with on-off switch for interior illumination.
 - b. One utility duplex receptacle with integral ground fault protection for electric tools, etc.
 - c. One space heater, 120 VAC in the enclosure and cable compartment.
4. Thermostatically controlled space heaters shall be located in the enclosure.
5. Bus and interconnections shall be of 99 percent IACS conductivity copper. Bus supports, bus, and interconnects shall withstand the stresses associated with the short-circuit rating of the disconnect switch. Bolted copper-to-copper connections shall be silver plated and made with a suitable number of plated steel bolts. Bolts shall be tightened to 45 ft.-lbs. torque, 2-hole NEMA drilling shall be provided for connection of all incoming and outgoing cables. The bus bars shall be insulated and clear bus boots shall be furnished for all joints and connections.
6. The ground bus shall have a short-circuit rating equal to that of the integrated assembly, a momentary and two second rating. The ground bus shall be bolted to a suitable bracket that shall be welded to the enclosure. Provisions for connection of two No. 250 kcmil bare copper conductor shall be accommodated on the ground bus.
7. All low-voltage components including control devices, and switch operators shall be located in grounded steel-enclosed compartments to provide isolation space heaters shall be enclosed within a grounded, steel guard. Low-voltage wiring shall be shielded, in grounded conduit or raceways where necessary to isolate it from high voltage.

8. To facilitate cable pulling and installation of cable-terminating devices, provisions shall be made for:
 - a. Adequate space below terminal pads for cable training and connections for terminal pads.
 - b. Cable tie down brackets shall be provided for cable support at 36" intervals minimum.
9. The outdoor, weatherproof construction, enclosure of each vertical section shall be constructed to maximize strength, minimize weight, and inhibit internal corrosion. The basic material shall be 11 gauge hot rolled, pickled and oiled, sheet steel. To guard against unauthorized or inadvertent entry, side and rear sheets shall not have externally removable bolts, the base of the assembly shaft consist of a continuous 3-inch structural-steel channel or equivalent.
10. Doors shall 11-gauge hot rolled, pickled and oiled, galvanized sheet steel. They shall have 90 degree flanges as well as deep overlapping between doors and door openings.
11. The door openings shall have 90 degree flanges, facing outward, for strength and rigidity.
12. Access control shall be provided as follows:
 - a. Units containing interrupter switches shall be provided with separate doors or panels for each compartment.
 - b. Doors providing access to interrupter switches shall be mechanically or key interlocked to guard against.
 1. Opening the door if the interrupter switch on the source side.
 2. Closing the interrupter switch if the door is open.
 - c. Doors providing access to the live compartments shall be interlocked to prevent access until the compartment is completely de-energized.
 - d. Doors and hinged bolted panels providing access to other high voltage components shall have provisions for padlocking.
13. Doors providing access to interrupter switches shall have viewing windows of shatterproof wire glass or polycarbonate (Lexan) and shall be large enough to permit viewing of the switch blade positions of all poles.
14. Louvers shall be provided at the top and bottom, on the front and rear of each unit.
 - a. Each louver shall be rain resistant and corrosion resistant. They shall have an Ins and baffle to protect against insertion of foreign objects and to exclude insects.
 - b. In consideration of exceptionally high concentrations of airborne dust, externally accessible glass-fiber filters shall be provided.
15. Lifting bars shall be removable.
16. All welds shall be ground and sanded (wire brushed if internal) to remove all scale and residues formed during welding, to remove oils and dirt and to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond and to resist rust. All surfaces shall be phosphatized before any protective coating is applied, following phosphatizing all metal surfaces will be given one coat of Plascon Acrylic Pigmented coating, Primer to be applied with

a wet mil thickness of 4.0 to 4.5. All coated surfaces are then heat cured in a catalytic, infrared, curing system. The final coat shall consist of Plascron Acrylic Pigmented coating; the color shall be ANSI 61. Final coat shall be applied at 1.0 to 1.5 mils dry. After enclosures are completely assembled and all components are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be carefully retouched by hand to restore the protective integrity of the finish. Paint color shall be specified by the customer. The manufacturer shall have performed a salt spray endurance test for a minimum of 2,000 hour continuous on the paint finish being proposed.

17. To guard against corrosion, all hardware, all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either non-ferrous materials or galvanized or plated ferrous materials.
18. Items necessary for outdoor weatherproof construction including but not limited to 120 VAC space heaters, and gasketing, shall be provided. Heater circuit shall be provided with a low voltage circuit breaker.
19. No drip compound shall be provided on the underside of the roof.
20. Interrupter Switches
 1. Interrupter switches shall have a duty cycle fault-closing rating equal to or exceeding the short circuit rating of the integrated assembly.
 2. Interrupter switches for manual operation shall be operated from the front of the vertical section by means of an externally mounted, non-removable handle and shall have provisions for padlocking in the open or closed positions.
 3. Interrupter switches shall use a quick-make, quick-break mechanism installed by the switch manufacturer and made an Integral part of the switch frame. It shall swiftly and positively open and close the interrupter switch independent of the switch handle speed or switch operator operating speed. "Teasing" of the switch poles shall not be permitted. The switch mechanism shall be designed so that the operation of the blades is push to close and pull to open.
 4. Interrupter switches shall have contacts of silver-to-silver construction for maximum current transfer, and shall provide constant high contact pressure. They shall have main and arcing contacts and be designed to provide maximum endurance for load interrupting and fault closing. The arcing contacts shall be "last in, last out", and designed to assist in interrupting and liberate no appreciable gases on interruption.
 5. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of correct switch position.
 6. The main blades shall be made of electrolytically pure copper. All contact points shall be heavily silver plated. The hinge and jaw components shall be one piece casting to provide maximum heat dissipation and continuous current transfer.

7. The switch assemblies shall have track resistant insulating barriers between the switch poles and side sheets. Barriers between poles shall be centered and the barriers at the sides shall have adequate clearance from the switch pole. These barriers shall be properly supported between barriers and from the side sheets to prevent excessive vibration at any point.

8. The switch shall have a full two-second short circuit rating as described above.

9. Interrupter switches shall be provided with auxiliary contacts (two N.O. and two N.C.) wired to terminal blocks.

E. Switch Motor Operators

1. Switch operators shall be a direct drive to the associated interrupter switch operating shaft and shall open and close the Interrupter switch through the quick-make quick-break mechanism.
2. Operating time shall be five seconds or less. Control voltage shall be 120 VAC or DC.
3. Pushbuttons shall be provided to permit local electrical open and close operation.
4. Interrupter switches with electric operators shall be provided with a removable manual operating handle to allow manual operation of the associated interrupter switch in the absence of control power. When the removable manual handle is removed from its storage position the motor control circuit shall be disconnected to prevent energization of the switch operator motor during manual operation.
5. Switch operators shall be mounted in a grounded, metal-enclosed low-voltage compartment providing isolation from high voltage.
6. Switch operators shall be equipped with a decoupling feature to permit testing and exercising of the switch operator without opening or closing the associated interrupter switch and without exposure to high voltage. It shall not be possible to recouple the switch operator to the interrupter switch unless the switch operator is in the same position as the interrupter switch.
7. Switch operators shall be equipped with an operation counter.
8. The switch operator shall be padlockable in the open or closed position.

F. Labeling

1. All external doors, hinged bolted panels, and internal doors providing access to high-voltage shall be provided with Danger High Voltage signs.
2. The integrated switchgear assembly shall be provided a nameplate indicating the manufacturer's drawing number and the following: nominal voltage, maximum design voltage, BIL, main bus continuous current, short circuit MVA, and momentary and fault closing rating.

3. Individual major components shall be provided with a nameplate indicating their applicable ratings.
- G. Provide all required 120V branch circuit(s) from electrical room to outdoor unit to allow the motor operated equipment to fully operate.

2.3 BUS AND BUS CONNECTIONS

- A. The buses within equipment supplied shall be fabricated of high conductivity radius edge rectangular copper bars as specified herein. Buses shall be designed to carry rated currents without exceeding the maximum allowable temperature rise as specified in ANSI, NEMA and IEEE standards when operating at specified rated overloads. Bus connections and joints shall have an ampacity equal to that of the bus ampacity, and fabricated so that there shall be no loss of conductivity during the life of the equipment.
- B. The entire contact area of all bolted current carrying connections in copper buses shall be factory silver-plated. Ring-plated method of silver plating and tin-plated contact surfaces shall not be acceptable. Silicon bronze bolts, nuts and Belleville washers, or approved equal shall be used. Connections shall be made with a minimum of two 1/2"-13 bolts at each end of the joint. Provide with installation materials, manufacturer's required bus joint hardware torque data. All hardware shall be torque in the presence of the Engineer.
- C. Phase sequence of buses, leads and terminals in the equipment shall be A, B, C top to bottom, left to right and front to rear. Phases shall be identified per NEMA Standards and as specified for buses in this Section.
- D. Clearly visible permanent phase identification (A, B, C, Neutral or ground) of each bus inside the switchgear shall be provided. Also, nameplates specifying whether the buses are line side or load side shall be provided.
- E. All 13.2 kV bus shall be fully epoxy insulated, while maintaining un-insulated bus spacing. All 600-volt (nominal) bussing shall either be dip insulated or heat shrink insulated, while maintaining un-insulated bus spacing. Sleeve type insulation is not acceptable. All bus, including main and run-back buses shall be insulated.
- F. Following field connection, all bus joints shall be insulated with suitable "boot" type insulation.
- G. Ground Studs: Provide copper ground studs for each switch on the line and load side bus terminals of the switch including the ground bus. Ground stud shall be copper, ball type, similar to Hubbell/Chance Standard Ball Stud, Cat. # C600-2102 or approved equal, complete with Grounding Stud Cover, Hubbell/Chance Cat. # C406-0416 or approved equal. Each pad-mounted unit shall also be furnished with a Hubbell/Chance Ball Socket Live Front Grounding set, Cat. # T600-2246 or approved equal.

2.4 IDENTIFICATION

- A. Materials: Refer to Division 26 Section 26 05 53 "Identification for Electrical Systems." Identify units, devices, controls, and wiring.

2.5 SOURCE QUALITY CONTROL

- A. Before shipment of equipment, perform the following tests and prepare test reports:
 - 1. Furnish reports which include results of design and production tests performed according to NEMA C37.72, IEC 60265-1 and IEC 62271-111. Production tests shall be performed by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.
- B. Assemble switchgear and equipment in manufacturer's plant and perform the following:
 - 1. Functional tests of all control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
 - 2. Functional test of all control and trip circuits.
- C. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.6 FACTORY FINISHES

- A. Finish: Manufacturer's light gray color finish applied to equipment before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.3 IDENTIFICATION

- A. Provide warning signs as specified in Division 26 Section 26 05 53 "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Cable terminations are specified in Division 26 Section 26 05 13 "Medium-Voltage Cables."
- B. As applicable, tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.
- C. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Division 26 Section 26 05 19 "Medium-Voltage Cables."

3.5 FIELD QUALITY CONTROL

- A. Performance of Acceptance Checks and Tests shall be in accordance with Form 816 Article 1.20-1.05.10 and as follows:
 - 1. Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards, utilizing a qualified independent testing and inspecting agency, as approved by the Designer.
 - 2. Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate information with specifications and approved shop drawings.
 - 2) Inspect physical and mechanical condition.
 - 3) Check for proper anchorage, alignment, required area clearances, and grounding.
 - 4) Perform mechanical operator tests in accordance with manufacturer's instructions.
 - 5) Inspect all indicating devices for proper operation.
 - b. Electrical Tests
 - 1) Perform contact-resistance tests.
 - 2) Perform insulation-resistance tests.
 - 3) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.
 - c. Grounding System
 - 1) Visual and Mechanical Inspection
Inspect ground system for compliance with contract plans and specifications.
 - d. Electrical Tests
 - 1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements

2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

e. Follow-Up Verification

1) Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that devices are in good operating condition and properly performing the intended function. Test shall require each item other than fuses, to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Department five working days in advance of the dates and times for checks and tests.

B. Remove and replace malfunctioning units and retest as specified above.

3.6 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

B. The Department reserves the right for the factory tests as outlined above to be witnessed by the Department or its' designated engineers.

1. Provide twenty-eight (28) days of advance notice for any factory test. Submit written test procedure for approval fifteen (15) days prior to any schedule factory test.

C. The manufacturer shall provide six (6) certified copies of any factory test report.

END OF SECTION 26 13 00

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Grout.
5. Common communications installation requirements.
6. Under slab conduit supports.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
1. Product Data: For sleeve seals.

1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications 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 pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section 08 31 00 "Access Doors and Panels."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section 07 84 00 "Firestopping."
- E. Prior to installation of equipment and supporting infrastructure in COMM/IT spaces, Contractor shall submit for approval proposed layouts in these spaces. Layouts shall be based on prior coordination with CONNDOT and MNR

1.5 WARRANTY

- A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Or Approved equal.
- C. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
- D. Pressure Plates: Include two for each sealing element.
- E. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with the latest version of 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 communications 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. Under slab conduit supports shall be configured and spaced as per details in the Structural Drawings.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 6 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section 07 92 00 "Joint Sealants".
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Firestopping".
- L. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. 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.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.

- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section 07 84 00 "Firestopping."

END OF SECTION 27 05 00