ADDENDUM NO. 1

NORTHWEST DEVELOPMENT AREA
WATER AND SANITARY SEWER IMPROVEMENTS
DAYTON INTERNATIONAL AIRPORT
(10% MBE Participation)

TO ALL BIDDERS:

This addendum, including all articles and corrections listed below, shall be taken into account in preparing the "Bid Forms" and shall become part of the Contract.

All bidders are requested to attach this Addendum to the Bid Forms and return to the City.

ITEM NO. 1

Include the following Supplemental Specifications within the Contract Document Specification Book:

1. Sanitary Sewer Forcemain – Base Bid Item SPL-1 and SPL-2
2. Air Release Valve – Base Bid Item SPL-3
3. Electrical Work – Pump Station Base Bid Item SPL-5
4. Meter Pit – Additive Alternate No. 4 Item SPL-1

ITEM NO. 2

In Contract Document Specification Book, Change:

Item SP-1 FACTORY PUMP STATION to: SPL-4 FACTORY PUMP STATION.

ITEM NO. 3

In All Contract Documents, Revise Completion Language and Number of Calendar Days;

From: Completion Date: 100 Calendar Days

To:

1. Base Bid Water and Sanitary Sewer/Force Main; Completion Date: 120 Calendar Days.
2. Base Bid Sanitary Sewer Pump Station, Fully Operational; Completion Date: Concurrent with the 120 Calendar Days (Base Bid) as noted in item 1 above.
3. Base Bid Pump Station Restoration Work: An additional 20 Calendar Days.
4. Base Bid Rock Excavation Alternate No. 2: Days will be added at no cost to Contract, based on Rock found, if any (as approved by the Engineer).
5. Water Main Additive Alternate No. 4: An additional 40 Calendar Days.

END OF ADDENDUM NO.1

March 5, 2018
Keith Steeber, Acting Division Manager
Department of Public Works

SUPPLEMENTAL SPECIFICATIONS
ITEM SPL-1 & 2 SANITARY SEWER FORCEMAIN

ITEM SPL-1& 2 SANITARY SEWER FORCEMAIN

1.01 Definition. Sanitary Sewer Forcemain shall be High Density Polyethylene Pipe (HDPE) pipe designated and classified as follows:

HDPE Forcemain Pipe, ASTM D3350, as PE 3408 IPS - DR

1.02 Description. This item shall cover the labor, materials, and incidentals necessary for the installation of fusion welded HDPE forcemain pipe as shown on the plans or as required by the Engineer and shall include the furnishing of the pipe, tracer wire, pipe specials, adapters, handling, storing, distributing and installing the sewer ready for testing; the furnishing of all testing materials, testing the sewer for tightness and remedying all defects. The pipe shall be installed according to the type of HDPE pipe shown on the plans, stated in the Proposal, and/or ordered by the Engineer.

1.03 Work Plan. Prior to beginning the HDPE work, submit a Work Plan detailing the procedure and schedule for work across the project. The Work Plan supplements the drawings and shall provide documentation that is required for planning a successful project. The plan shall address the following at a minimum:

(a) Findings of Investigation per Section 1.04

(b) Pipeline Assembly

(c) Drilling Operations

(d) Site layout to include entry and exit points, for directional drilling work

(e) Equipment to be utilized

(f) Drilling Fluids Management Plan, for directional drilling work

(g) Pipe storage and handling details

(h) Security

(i) Contingency Plan for Possible issues

(j) As-built Procedure

1.04 Material. High Density Polyethylene (HDPE) Pipe shall conform to type shown on the detailed plans and in the proposal.

Materials used for the manufacture of polyethylene pipe and fittings shall be made from high density, extra high molecular weight compound equaling PE-3408 designation and shall conform to ASTM-1248 and ASTM-3350 with a cell classification of 345444C or 345444E. the manufacturer shall certify that the materials used to manufacturer pipe and fittings meet these requirements.

The minimum Size and Pressure Class/DR rating acceptable shall be:

a) Size = 6-inch

b) Class = 200 / DR 9

Tracer wire shall be unshielded 10 gage copper wire conductive tape.

1.05 Pipe Installation. The manufacturer of the HDPE pipe furnished shall provide installation instructions and literature to the Contractor so that he will be aware of the Manufacturer's recommended procedure and practice of installing pipe and fittings.

The following work shall be provided:

1. Review and Investigation:

(a) The Contractor and Direction Drilling Contractor shall review and investigate entry and exit bore pit locations as shown on the plans to determine best and exact location of bore pits. Bore pit locations as shown are subject to change based on review and findings of investigation of the Contractor. In no case can a bore pit be located within the runway safety area as shown in the Safety Plan within the drawings.

(b) Known utilities are shown on the plans with depths given based on best available information. All utilities shall be field-located and potholed. The Vectren gas main and any electrical utilities within the airfield shall be located by hand digging or with a hydro-excavator to confirm the depths.

(c) Soil boring logs are provided as part of these Technical Specifications. Contractor shall review and investigate any area of concern prior to directional drilling. Rock encountered, as defined in Item 811, in open cut trenching shall be ripped out and paid as Rock Excavation per Item 811.

(d) Review, investigation and layout cost shall be included in Item 623 – Construction Layout and As-built.

2. Pipe Assembly:

(a) The Contractor shall be trained by the Manufacturer or Manufacturer's Authorized Representative in Fusion Procedures.

(b) The Contractor shall be required to demonstrate successful field experience.

(c) Care shall be taken to protect HDPE pipe from prolonged exposure to heat or direct sunlight (ultraviolet rays) during construction.

(d) Joints:

Joints between plain end pipes and fittings shall be made by butt fusion. Joints between the main and saddle branch fittings shall be made using saddle fusion. The butt fusion and saddle fusion procedures used shall be procedures that are recommended by the pipe and fitting Manufacturer.

Pipe and fittings fusion joining shall be in accordance with manufacturer recommended procedures and ASTM D-2161. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall match the outside diameter and minimum wall thickness specifications of ASTM D-1248 for the same size pipe.

Joining of the pipes and fittings shall be performed in accordance with ASTM D-2774. Depending upon the installation requirements and site location, joining shall be performed within or outside the excavation. Joints of the pipe sections shall be smooth on the inside and internal projection beads shall not be greater than 3/16 inch.

The tensile strength at yield of the butt-fusion joints shall not be less than the pipe. A specimen of the pipe cut across the butt-fusion joints shall be tested in accordance with ASTM D-638

(e) Fittings:

All fitting shall be provided as indicated on the plans. HDPE Fittings shall be of the same material and class as the pipe and shall be manufactured by the

manufacturer of the pipe. HDPE Elbows, tees, and wyes shall be manufactured by mitered fabrication. The manufacturer shall have a written specification for all standard mitered fittings, which establishes Quality Control criteria and tolerances. The manufacturer may be required to demonstrate its ability to produce product required by this specification.

Mechanical joint anchor fittings (MJ Adapter or Harvey Adapter) shall be used to transition from ductile iron to HDPE and from HDPE to PVC. The fitting shall be stronger than the pipe in that when it is subjected to tensile stress the pipe will pull apart before the fitting will pull out and the pipe will blow before the fitting will rupture under pressure.

The MJ Adapter shall have a pre-installed stainless-steel stiffener, in accordance with Plastic Pipe Institute (PPI) recommendations, to neutralize point-loading, ACQ, creep and loss of gasket seal due to diameter contraction. The stiffener shall be engineered sufficiently thick to avoid redial buckling due to gasket pressure.

The MJ Adapter requires longer bolts and shall be sold with the modified longer bolt kit to avoid construction crew delays or improper installation with too short bolts.

All fittings for forcemains or pressure rated fittings shall be rated according to the manufacturer's written specifications, and clearly labeled on the fittings as such.

3. Installation Method:

Pipe segments shall be fused together in one length, space permitting, installed by open cutting the trench or direction drilling, as shown on the drawings per the following:

A. Open Cutting:

The pipe shall be installed as described in Section 810 - Excavation and Backfill of these specifications and per the Proposal form.

Pipe will be installed at a minimum depth of 4'-0".

The trench shall be free of all standing water prior to installation of the pipe.

Tracer wire will be installed above the pipe. Terminal blocks shall be provided.

At the close of each day's work, and at such other times when pipe is not being laid, the end of the pipe shall be protected with a close-fitting stopper.

Following installation, the pipe is to be pressure tested in accordance with Item 802. The method of testing shall be as recommended by the manufacturer and approved by the Engineer.

As-built the pipe per Special Provisions and Construction Layout and As-built Section.

B. Directional Drilling:

Pipe will be installed at a minimum depth of 4'-0", subject to rock not being encountered.

If an obstruction is encountered during drilling, notify ENGINEER immediately. Do not proceed around obstruction without ENGINEER's approval.

Pipe shall be placed on rollers before pulling into bore hole spaced close enough to prevent sagging of the pipe.

Install piping with horizontal and vertical alignment as shown on Drawings and per the Work Plan.

At the close of each day's work, and at such other times when pipe is not being laid, the end of the pipe shall be protected with a close-fitting stopper.

Following installation, the pipe is to be pressure tested in accordance with Item 802. The method of testing shall be as recommended by the manufacturer and approved by the Engineer.

Drilling Procedures shall include:

1) Drilling Pilot Hole

   a) Drill pilot bore with vertical and horizontal alignment as indicated on Work Plan.

   b) Guide drill remotely from ground surface to maintain alignment by monitoring signals transmitted from drill bit.
      1. Monitor depth, pitch, and position.
      2. Adjust drill head orientation to maintain correct alignment.

   c) Inject drilling fluid into bore to stabilize hole, remove cuttings, and lubricate drill bit and pipe.

   d) Continuously monitor drilling fluid pumping rate, pressure, viscosity, and density while drilling pilot bore, back reaming, and installing pipe to ensure adequate removal of soil cuttings and stabilization of bore.

1. Provide relief holes when required to relieve excess pressure.
2. Minimize heaving during pullback.

e) Calibrate and verify electronic monitor accuracy. Excavate test pits as needed along the bore to verify required accuracy.

After completing pilot bore, remove drill bit.

2) Reaming the Hole

a) Once the pilot hole has been established, begin hole opening process. Determine reamer size based on field conditions.

b) Ream hole to allow adequate opening for size of pipe.

c) Reaming process may need repeated to open bore hole.

d) Inject drilling fluid through reamer to stabilize bore and lubricate pipe.

3) Pulling the Pipe

a) Once the back-reaming process is completed, push drill stem through bore hole and attach pipe to pipe pulling head.

b) Protect and support pipe being pulled into bore hole so pipe moves freely and is not damaged during installation.

c) Do not exceed pipe manufacturer's recommended pullback forces.

d) Install trace wire continuous with each bore. Splice trace wire only at intermediate bore pits. Tape or insulate trace wire to prevent corrosion and maintain integrity of pipe detection.

e) Provide sufficient length of pipe to extend past termination point to allow connection to other pipe sections.

f) Allow minimum of 24 hours for stabilization after installing pipe before making connections to pipe.

g) Mark location and depth of bore with spray paint on paved surfaces, and wooden stakes for as-builting. As-built the pipe per Special Provisions and Construction and As-Build Section.

4. Slurry Removal and Disposal

A. Contain excess drilling fluids at entry and exit points until recycled or removed from site. Provide recovery system to remove drilling spoils from access pits.

B. Remove, transport and legally dispose of drilling spoils off site.
   1. Do not discharge drilling spoils in sanitary sewers, storm sewers, or other drainage systems.
   2. When drilling in suspected contaminated soil, test drilling fluid for contamination before disposal.

C. When drilling fluid leaks to surface, immediately contain leak and barricade area from vehicular and pedestrian travel before resuming drilling operations.

D. Complete cleanup of drilling fluid.

1.06 Measurement. The pipe to be paid for will be the actual number of linear feet of completed pipe (in place) measured horizontally along the sewer centerline. Measurements shall be taken to centerline intersections. The measurement of the pipe shall be taken through tunnels, manholes, other similar structures, specials and other like construction.

1.07 Payment. Payment for furnishing and installing forcemains pipelines, complete and operational, will be made per linear for of the size and type installed.

The price(s) bid shall include furnishing and installing all pipe, fittings, and joining materials; furnishing materials for and constructing all anchorages and buttresses; connecting to existing pipelines; installing tracer wire; testing; and all incidentals items of work necessary to satisfactorily complete and make the force main operations.

Item	Unit	Description
SPL-1	Linear foot	___" HDPE Pipe, DR9, Open Cut
SPL-2	Linear foot	___" HDPE Pipe, DR9, Directional Drilling

END OF SANITARY SEWER FORCEMAIN

SUPPLEMENTAL SPECIFICATIONS
ITEM SPL-3 AIR RELEASE VALVE AND APPURTENANCES

ITEM SPL-3 AIR RELEASE VALVE AND APPURTENANCES

1.01 Description. This item shall cover the labor, materials, and incidentals necessary for the installation of an air release valve complete with a plug valve and piping installed in a 6-ft diameter manhole and shall include the furnishing of the air release valve, manhole, hatches, pipe, fittings, valve, specials, adapters, handling, storing, distributing and installing the meters ready for service.

1.02 Material. All materials shall be provided as shown on the plans and detail drawings for a complete installation. Materials shall include:

1. AIR RELEASE VALVE MANHOLE shall be pre-fabricated concrete manhole 6 feet in diameter with a depth designed for the sanitary sewer forcemain.

   The manhole top shall come with a Bilco (36" x 36") Single Leaf Aluminum J-2AL lid, Neenah (Cat No. R-6660-NH) or approved equal. Optional locking hasp shall be included with the lid.

   The top slab shall have cast in place lifting lugs designed and rated for lifting the slab.

   Manhole construction shall be in conformance to City of Dayton Item 830 – Manholes.

2. AIR RELEASE VALVE shall be 4" Combination Air / Vacuum Valve designed for Wastewater services.

   Valve and body shall be of ASTM A126 Class B cast iron with rubber permanently bonded to all interior surfaces and body faces and have flanged end complying with ASTM/ANSI B16.1 Class 125 pattern.

   The float, plug, guide shafts shall be constructed of Type 316 stainless steel. Resilient seats shall be Bun-N.

   The body shall have a 2" NPT cleanout and a 1" NTP drain connection on the side of the casting.

Shall meet or exceed all applicable requirements of ANSI/AWWA C512 Standards.

Valve shall be manufactured by Val-Matic and be a VM-800-S series or an approved equal.

3. PLUG VALVE shall be 4" in size and shall meet the following design criteria and be manufactured of materials meeting the following specifications. All plug valves provided shall conform to the latest revision of ANSI/AWWA C517 except as modified herein.

   Plug valves shall be an eccentric valve designed for use with wastewater for drip tight shutoff and throttling services. Plug valves shall have 100% port area.

   Valve and body shall be of ASTM A126 Class B cast iron with rubber permanently bonded to all interior surfaces and body faces and have flanged end complying with ASTM/ANSI B16.1 Class 125 pattern. Plug shall be totally covered with rubber to incorporate a compression fit where rubber lining on plug meets rubber lining on cover and body.

   Seat shall have a 90% nickel seating surface welded to the body seat ring. The seat will be attached to the body housing where it shall be considered an integral part of the body housing.

   Valve shaft seals shall be cartridge shaft seals manufactured in accordance with AWWA C504 and C507 utilizing two "O" ring seal glands in a removable bronze cartridge. A grit seal shall be installed to act as a barrier between the line media and the cartridge seal area.

   Pressure rating shall be 175 psi.

   Testing shall include a hydrostatic and seat test, with certified results supplied to the owner. An operational test will be conducted at the site after installation.

   Valves shall be supplied with 2-inch operating nuts constructed out of ductile iron.

   Plug valves shall be bi-directional flow. Valves shall have smooth, unobstructed, oversized flow way.

   Valve shall be manufactured by DeZurik or an approved equal.

1.03 Installation. Valve and manhole installation shall be in accordance to the Manufacturer Recommendations, per Technical Sections 800 through 830 and to the Details provided within the drawings. Location shall be as shown on the drawing.

1.04 Measurement. Per assembly, complete. Includes the air release valve, plug, HDPE to DIP fitting, piping, manhole, hatches, supports furnished and installed.

1.04 Payment. The price(s) bid shall include furnishing and installing all air release valve compete with plug valve in a manhole.

Item	Unit	Description
SPL-3	EA	Air Release Valve in MH, Complete

END OF AIR RELEASE VALVE

PUMP STATION BASE BID ITEM SPL - 5

DIVISION 26 – ELECTRICAL

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Electrical Contractor for this work is referred to the Bidding Requirements, General Conditions, Special Conditions, Temporary Services, Plumbing, HVAC and pertinent Sections of Division 1 Specifications. These sections describe work which is a part of this Contract. The following General Provisions amplify and supplement these Sections of Division 1. In cases of conflicting requirements, the stipulations set forth in Division 1 supersede and must be satisfied by the Contractor.

B. Submit shop drawings, operation/maintenance manuals and record as-built drawings as called for in Division 1.

C. Any substitutions the Contractor wishes to bid must be done following the format and procedures described in Division 1.

1.02 SUMMARY

A. Furnish all materials, labor, tools transportation, incidentals and appurtenances to complete in every detail and leave in working order all items of work called for herein or shown on the accompanying Drawings.

B. Include any minor items of work necessary to provide a complete and fully operational electrical system.

1.03 GENERAL REQUIREMENTS

A. The Electrical Contractor must read the entire Specifications covering other branches of work. He is responsible for coordination of his work with work performed by other trades.

B. Consult all contract Drawings which may affect the location of any equipment or apparatus furnished under this work and make minor adjustments in location as necessary to secure coordination.

C. The layout shown on the Drawings is based on a particular make of equipment. If another make of equipment is used which requires modification or changes of any description from the Drawings or Specifications, Contractor shall be responsible (as a part of this work) for making all such modifications and changes, including those involving other trades, with the cost thereof included in his Bid.

The Electrical Contractor is responsible for the dimensional correctness of all items of equipment he intends to utilize, and shall coordinate same with other trades, Drawings, etc., to avoid conflicts. In such case, Contractor shall submit Drawings and Specifications prior to starting work showing all such modifications and changes. His proposal shall be subject to the approval of the associate.

D. System layout is schematic and exact locations shall be determined by structural and other conditions. This shall not be construed to mean that the design of the system may

be arbitrarily changed. The equipment layout is to fit into the building as constructed and shall be coordinated with the equipment included under other Divisions of work.

E. The Electrical Contractor is to contact the associate immediately if he notices any discrepancies or omissions in either the Drawings or the Specifications or if there are any questions regarding the meaning or intent thereof.

F. Submit all changes, other than minor adjustments, to the associate for approval before proceeding with the work.

G. The Electrical Contractor is required to visit the site and fully inform himself concerning dimensions, existing conditions and all other conditions affecting the scope of work. Failure to visit the site shall not relieve the Contractor from any responsibility in the performance of his work.

H. All workmanship is to be of the highest quality in accordance with the best practices of the trade and performed by craftsmen skilled in this particular work.

I. The Electrical Contractor is to have a competent superintendent in charge of the work installed under this Contract. Superintendent is to be experienced in this type of work.

1.04 PERMITS, INSPECTIONS AND CODES

A. Electrical Contractor shall file all Drawings, pay all fees and obtain all necessary permits and certificates of inspection relative to this work.

B. Completed installation shall conform with ALL applicable Federal, State and Local Laws, Codes and Ordinances including but not limited to the latest editions of the following:

1. Ohio Building Code (OBC)
2. Specific Construction Safety Requirements, State Industrial Commission
3. National Electrical Code (NFPA-70)
4. Life Safety Code NFPA 101
5. Occupational Safety and Health Act (OSHA) of 1971 and all amendments thereto
6. B.O.C.A.
7. National Building Code

C. Nothing contained in the Drawings and Specifications shall be construed to conflict with these laws, codes and ordinances and they are hereby included in these Specifications.

1.05 DRAWINGS

A. Drawings are schematic and show approximate locations of electrical equipment. Exact locations should be coordinated by Contractor and verified in field. It shall be part of the Contractor's responsibility to check and verify the physical size of the specified equipment he intends to utilize.

B. Significant deviations from Drawings must be approved by the Associate.

C. The Associate reserves the right to change the location of outlets and equipment (maximum 10 ft.) up to the time of roughing-in, without additional cost.

D. If a typical plan or detail is shown that requires a reversed installation on the job site, the Contractor shall be responsible for the reverse installation as part of this contract.

1.06 ELECTRICAL MOTORS

A. In general, motors will be furnished and installed under other Divisions of work as a factory installed item. Unless factory installed on the unit, all wiring, motor starters, safety disconnect switches or combination starter/disconnect switches (fused or nonfused as required) shall be furnished and installed by this Contractor.

1.07 DISCONNECT SWITCHES

A. In general, disconnect switches shall be installed in accordance with national and local codes. Disconnect switches that are installed at pumps and other types of equipment shall be fused or non-fused in accordance with the equipment's nameplate requirements per N.E.C. 440-21 and 110-3(b).

1.08 SEQUENCING AND SCHEDULING

A. Construct work in sequence as called for in General Provisions.

1.09 INSPECTION

A. Contractor arranges for and includes in his bid, inspection of this work by ONE of the following:

1. Local Code Authority
2. State Code Authority
3. Certified private inspection agency.

1.10 GUARANTEE AND ONE YEAR SERVICE CONTRACT

A. Contractor is responsible for all defects, repairs and replacements in materials and workmanship for a period of one (1) year after final payment is approved by the associate.

B. Contractor shall furnish a one year service contract for major items of electrical equipment which require on-going maintenance. The cost of this one year service contract shall be included in Base Bid; see individual Specifications for items of equipment that require this maintenance contract.

1.11 CADD FILES

A. A set of electronic CADD files of the Drawings will be made available to the Contractor by the Engineer at a cost of $50 per drawing. These files will be issued at contractor's request for the sole purpose of coordination of work on this project and shall not be used for any other purpose whatsoever without written approval by the Engineer.

B. Due to the nature of electronic media, the Engineer/Architect cannot warrant the accuracy of data contained in electronic drawing files. Any use or reuse of original or altered design materials by the Contractor or other parties without the review and written approval of the Engineer/Architect shall be at the sole risk of the Contractor. Furthermore, the Contractor agrees to defend, indemnify and hold Engineer harmless from all claims, injuries, damages, losses, expenses and attorney fees arising out the modification or reuse of these materials.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Furnish new and undeteriorated materials of a quality not less than what is specified.

B. Contractor is to furnish and install only those brands of equipment mentioned specifically or accepted as substitutions.

2.02 EQUIPMENT SELECTION AND APPROVAL

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands of manufacturer of equipment or materials are listed in the Specification, the exact equipment listed shall be used in the bid. Where more than one name is listed, Contractor may select any one of the several brands specified.

B. Within ten (10) days after the award of contracts, the Contractor must submit a list to the Associate showing the names of manufacturers and subcontractors he intends to use.

PART 3 - EXECUTION

3.01 PROTECTION AND CLEANING

A. Protect all fixtures against damage from leaks or abuse and pay the cost of repair or replacement of fixtures or equipment made necessary by failure to provide suitable safeguards or protection.

B. After all equipment has been inspected and approved, thoroughly clean all equipment provided under this work.

C. After all fixtures have been installed, thoroughly clean all fixtures, remove all stickers visible after installation and/or as directed by the associate, remove foreign matter and leave every part in acceptable condition, clean and ready for use. Install new lamps as called for in Lighting Sections and check for satisfactory operation.

D. All scratches and chipped prime or finish coats on all electrical equipment are to be touched-up with matching paint. All dents in all electrical equipment are to be removed and the prime or finish coats touched-up. If damage is excessive, replacement may be required.

3.02 CUTTING AND PATCHING

A. Cut and patch as required to install new work. Patching must match existing surfaces in kind and finish.

B. Cut as necessary to install new equipment. Avoid cutting of concrete, masonry and other work by use of inserts and sleeves.

C. Give the General Contractor locations and sizes of all openings required for the installation of equipment before construction and walls are started. If it becomes necessary to cut into new work because of the failure of Contractor to notify the General Contractor, then the General Contractor shall do any necessary cutting and patching at this Contractor's expense.

D. Patching must match existing surfaces in kind and finish and shall be done by the General Contractor at this Contractor's expense.

3.03 EXCAVATION AND BACKFILL

A. Provide any trenching required to install underground utility service or wiring. Remove forms and debris before backfilling. Tamp and compact backfill in six (6") inch layers to bring level with existing grade. Replace and patch surface to match existing sod, gravel, blacktop or concrete. See General Specification, Excavation and Backfill Section for the percentage of compaction of the backfill required. Failure to achieve this percentage will require removal of backfill installed and new backfill installed.

3.04 FOUNDATIONS AND SUPPORTS

A. Contractor is fully responsible for the installation of the concrete equipment pads and conduit encasement. All other concrete work is the responsibility of the General Contractor. Coordinate exact foundation, curb and pad sizes with General Contractor.

B. Install galvanized steel frames for equipment and auxiliary steel supports as necessary.

3.05 CONDUIT SLEEVES

A. Sleeves shall be installed in all walls and slabs where conduits or raceways are to pass through.

B. Provide caulking and sealing for a water proof assembly.

C. Where openings in floors and walls are required and sleeves were not installed, this Contractor shall be responsible for cutting all required openings with rotary type drill, or other method approved by associate. Holes cut with pneumatic hammer will <u>not</u> be acceptable.

END OF SECTION 26 05 00

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specifications Section, apply to this Section.

1.02 SUMMARY

A. This Section includes:

1. Building wire and cable.

2. Nonmetallic-sheathed cable.

3. Underground feeder and branch circuit cable.

4. Service entrance cable.

5. Armored cable.

6. Metal clad cable.

7. Wiring connectors and connections.

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide for each cable assembly type.

C. Test Reports: Indicate procedures and values obtained.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.04 QUALITY ASSURANCE

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years documented experience.

1.06 PROJECT CONDITIONS

A. Verify exact measurements in field.

B. Conductor sizes are based on copper. Aluminum conductors will not be allowed.

C. Wire and cable routing shown on Drawings is approximate. Route wire and cable as required to meet Project Conditions.

D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.07 COORDINATION

A. Coordinate Work under provisions of Division 1.

B. Determine required separation between cable and other work.

C. Determine cable routing to avoid interference with other work.

PART 2 - PRODUCTS

2.01 Manufacturers: Subject to compliance with requirements. Provide products by one of the following:

1. Laribee.

2. Pirelli.

3. Southwire.

4. Cablec.

2.02 BUILDING WIRE AND CABLE

A. Description: Single conductor insulated wire.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN/THWN.

2.03 METAL CLAD CABLE

A. Description: ANSI/NFPA 70, Type MC.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 75 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Aluminum.

G. Armor Design: Corrugated tube.

H. Jacket:
1. Plastic jacket shall be used on flexible conduit exposed to outdoor or moist locations.
2. Any type in all other locations.

I. Minimum Size: ½" for fixture whips and ¾" for motor connections.

J. Maximum Length: 6 feet.

2.04 INSULATION COLOR CODE

A. All wire shall have factory colored insulation as follows:

	208Y/120V	480Y/277V
Phase A	Black	Yellow
Phase B	Red	Orange
Phase C	Blue	Brown
Neutral	White	White or Gray each with identifiable colored stripe
Ground	Green	Green with Yellow stripe
Emergency	Same as normal, but with ½-inch red tape wrapped twice around wire at a maximum 12-inch intervals at access points.	

Conductors larger than #8 AWG that are not factory color coded shall be marked with colored tape at accessible locations.

2.05 WIRING CONNECTORS

A. Split Bolt Connectors:

1. Blackburn.
2. Burndy.
3. Panduit.
4. Substitutions: Under provisions of Division 1.

B. Solderless Pressure Connectors:

1. Blackburn.
2. Burndy.

3. Panduit.
4. Substitutions: Under provisions of Division 1.

C. Insulated spring wire connectors:

1. 3M “Scothlok”.
2. Ideal Co. “Wingnut”.
3. T&B “Piggy”.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

3.02 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.03 WIRING METHODS

A. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

B. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

C. Exterior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

D. Underground Installations: Use only building wire, Type THHN/THWN insulation, in raceway.

3.04 INSTALLATION

A. Install products in accordance with manufacturers instructions.

B. Use solid or stranded conductor for feeders and branch circuits 10 AWG and smaller.

C. Use stranded conductors for control circuits.

D. Use conductor not smaller than 12 AWG for power and lighting circuits.

E. Use conductor not smaller than 14 AWG for control circuits.

F. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

G. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

H. Pull all conductors into raceway at same time.

I. Use suitable wire pulling lubricant for building wire.

J. Protect exposed cable from damage.

K. Support cables within enclosures, using metal cable ties to support cables from structure.

L. Use suitable cable fittings and connectors.

M. Neatly train and lace wiring inside boxes, equipment, and panelboards.

N. Clean conductor surfaces before installing lugs and connectors.

O. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

P. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

Q. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

R. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.05 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Section 26 05 53.

B. Identify each conductor with its circuit number or other designation as required.

3.06 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of Division 1.

B. Inspect wire and cable for physical damage and proper connection.

C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

D. Verify continuity of each branch circuit conductor.

E. Verify continuity of connections.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.03 SUBMITTALS

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

B. Field quality-control test reports.

1.04 QUALITY ASSURANCE

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Insulated Conductors: **Copper** wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.02 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch by10 feet.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.02 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.

3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
10. All pumps, air handlers and other equipment items.

B. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

C. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.03 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.

    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 5 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Coordination Drawings: Conduit routing 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. Structural members in the paths of conduit groups with common supports.

1.05 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 METAL CONDUIT AND TUBING

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

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. O-Z Gedney; a unit of General Signal.
3. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. EMT: ANSI C80.3.

E. FMC**:** Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Fittings for EMT: Steel or die-cast, set-screw type.
2. Fittings for RMC and IMC to be threaded.

2.02 NONMETALLIC CONDUIT AND TUBING

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

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. ARNCO Corp.
3. Beck Manufacturing.
4. Cantex, Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSys, Inc.
8. Electri-Flex Company.
9. IPEX Inc.
10. Lamson & Sessions; Carlon Electrical Products.
11. Manhattan/CDT; a division of Cable Design Technologies.
12. Spiraduct/AFC Cable Systems, Inc.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.03 METAL WIREWAYS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.04 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers.

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

a. Thomas & Betts Corporation.
b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from **manufacturer's standard** colors.

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

a. Butler Manufacturing Company; Walker Division.
b. Enduro Systems, Inc.; Composite Products Division.
c. Hubbell Incorporated; Wiring Device-Kellems Division.
d. Lamson & Sessions; Carlon Electrical Products.
e. Panduit Corp.
f. Walker Systems, Inc.; Wiremold Company (The).
g. Wiremold Company (The); Electrical Sales Division.

2.05 BOXES AND ENCLOSURES

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

1. Hoffman.
2. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
3. RACO; a Hubbell Company.
4. Spring City Electrical Manufacturing Company.
5. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Cast or sheet metal, fully adjustable.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2.06 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: **Green**.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE."
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.

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

a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of fiberglass.

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

a. Carson Industries LLC.
b. Nordic Fiberglass, Inc.

2.07 SLEEVES FOR RACEWAYS

A. Provide sleeves for raceways as specified in Division 26 Section " Common Work Results for Electrical."

2.8 SLEEVE SEALS

A. Provide sleeve seals as specified in Division 26 Section "Common Work Results for Electrical."

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

2.9 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Al;uminum **conduit**.
2. Concealed Conduit, Aboveground: **Rigid steel conduit**.
3. Underground Conduit: RNC, Type EPC-**40**-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): **LFMC**.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type **3R**.
6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: **Fiberglass enclosures with polymer-concrete frame and cover**, SCTE 77, Tier 15 structural load rating.
b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: **Heavy-duty fiberglass units with polymer-concrete frame and cover**, SCTE 77, Tier 8 structural load rating.

c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: **EMT**.
2. Exposed and Subject to Severe Physical Damage: **Rigid galvanized steel conduit**. Includes raceways inside pump stations
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
4. Damp or Wet Locations: **Rigid aluminum conduit**.
5. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, **stainless steel** in damp or wet locations.

C. Minimum Raceway Size: **3/4-inch (21-mm)** trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

F. Conceal conduit under slabs and floors, unless otherwise indicated.

G. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Change from ENT to rigid steel conduit before rising through the slab. Provide rigid steel elbow through slab.

H. Raceway Terminations: Use insulating bushings in all conduits to protect conductors, including conductors smaller than No. 4 AWG.

I. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

J. Raceways for Optical Fiber and Communications Cable:

1. Install raceways, metallic and nonmetallic, rigid and flexible, as follows: Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

K. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of pump stations.
2. Where otherwise required by NFPA 70.

L. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

M. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid aluminum conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple aluminum conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished paving. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as

indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Provide conduit sleeves and seals as specified in Division 26 Section “Common Work Results for Electrical.”

3.06 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for **direct-buried and concrete-encased** duct banks**, and in single duct runs**.
2. Handholes and boxes.
3. Manholes.

1.03 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes**, and other utility structures**.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. **Ladder Step** details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

E. Product Certificates: For concrete and steel used in precast concrete **manholes and handholes**, as required by ASTM C 858.

F. Source quality-control test reports.

G. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store **precast concrete and other factory-fabricated** underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.07 PROJECT CONDITIONS

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

1. Notify **Owner** no fewer than **two** days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without **Owner's** written permission.

1.08 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.09 EXTRA MATERIALS

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

B. Furnish cable-support stanchions, arms and associated fasteners in quantities equal to **5** percent of quantity of each item installed.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, **Type EPC-40-PVC** UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.03 PRECAST CONCRETE HANDHOLES AND BOXES

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

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, **"ELECTRIC." "TELEPHONE." As indicated for each service.**

7. Configuration: Units shall be designed for flush burial and have **open** bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension shall provide increased depth of [**12 inches (300 mm)**]
    b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

9. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

10. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: **Green**.
2. Configuration: Units shall be designed for flush burial and have **open** bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, **"ELECTRIC." "TELEPHONE." As indicated for each service.**
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. CDR Systems Corporation.
    d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

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

a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of **fiberglass**.

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

a. Carson Industries LLC.
b. Christy Concrete Products.
c. Nordic Fiberglass, Inc.
d.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be **plastic**.

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

a. Carson Industries LLC.
b. Nordic Fiberglass, Inc.
c. PenCell Plastics.

2.05 PRECAST MANHOLES

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

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858**, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article** and with interlocking mating sections, complete with accessories, hardware, and features.

1. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.
b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.06 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.07 UTILITY STRUCTURE ACCESSORIES

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

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, **gray cast iron complying with ASTM A 48/A 48M, Class 30B** with milled cover-to-frame bearing surfaces; diameter, **29 inches (737 mm)**.

    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

    a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
    c. Legend: "SIGNAL" for communications, data, and telephone duct systems.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

I. Cable Rack Assembly: Steel, **hot-dip** galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

L. Fixed Manhole Ladders: Arranged for attachment to **wall** of manhole. Ladder and mounting brackets and braces shall be fabricated from **hot-dip galvanized steel**.

M. Portable Manhole Ladders: UL-listed, heavy-duty **fiberglass** specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm).

N. Cover Hooks: **Light duty, designed for lifts less than 60 lbf (270 N)**.

2.08 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type **EPC-40**-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type **EPC-40**-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type **EPC-40**-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type **EPC-40**-PVC, in concrete-encased duct bank, unless otherwise indicated.

E. Underground Ducts Crossing **Driveways, Roadways and Railroads**: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.02 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less**, Including Telephone, Communications, and Data Wiring**:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, **H-20** structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: **Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15** structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: **Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier8** structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: **Fiberglass-reinforced polyester resin**, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Manholes: **Precast or cast-in-place** concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.03 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.04 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of **48 inches** , both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3

inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

3.05 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "**Elastomeric Sheet Waterproofing**." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes **and handholes** after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and

touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms **and insulators,** as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

K. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. For enclosures installed in **asphalt paving and concrete** and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on **compacted earth**.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.07 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole **and handhole** grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.09 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.03 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.04 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.05 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.01 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.02 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.04 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.05 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with white letter on black background.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.06 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.07 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches (50 mm) high, with snap-around labels, Repeat legend at 10-foot (3-m) maximum intervals.

C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands:

1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Combined Fire Alarm and Security System: Red and blue.

D. Conductors to Be Extended in the Future: Attach **write-on tags** to conductors and list source and circuit number.

E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

H. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label attached with screws. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label attached with screws.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

    a. Panelboards, electrical cabinets, and enclosures.
    b. Access doors and panels for concealed electrical items.
    c. Electrical switchgear and switchboards.
    d. Transformers.
    e. Disconnect switches.
    f. Enclosed circuit breakers.
    g. Motor starters.
    h. Push-button stations.
    i. Power transfer equipment.
    j. Contactors.
    k. Power-generating units.

3.02 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

E. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be **factory applied**.
2. Colors for 208/120-V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Colors for 480/277-V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

H. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION

SUPPLEMENTAL SPECIFICATIONS
ALTERNATE NO. 4 ITEM SPL-1 METER PIT AND CHECK VALVE ASSEMBLY

ALTERNATE NO. 4 ITEM SPL-1 METER PIT AND CHECK VALVE ASSEMBLY

1.01 Description. This item shall cover the labor, materials, and incidentals necessary for the installation of meters and check valves in separate pits as shown on the plans and shall include the furnishing of the meters, meter vaults, hatches, pipe, fittings, valves, check valves, specials, adapters, handling, storing, distributing and installing the meters ready for service.

A total of 2 meter pit and check valve assembly are required. The first meter pit and check valve assembly will flow towards the airport; the second meter pit and check valve assembly will flow away from the airport.

The meters, vaults, valves and piping shall be furnished and installed according to the standard City of Dayton meter pit details for Meters 6" & Larger Meter Pit Installation with exception noted within.

1.02 Material. All materials shall be provided as shown on the plans and detail drawings for a complete installation. Materials shall include:

1. METER VAULT shall be a pre-fabricated concrete meter vault sized for an 8" fire line meter. Inside dimensions shall be minimum 13'0" (L) x 8'-0" (W).

   Top slab shall be designed by a Registered Engineer.

   The vault lid shall be a Bilco (48" x 48") Double Leaf Aluminum JD-2AL or approved equal. Optional locking hasp shall be included with the lid. The lid shall be drilled to accept Orion Beacon modules.

   Vault steps shall be polypropylene.

   A submittal from the concrete pre-casting manufacturer is required for approval by the Engineer prior to manufacturing.

2. CHECK VALVE MANHOLE shall be pre-fabricated concrete manhole 6 feet in diameter and 6 feet in depth designed for off-road use with openings as shown on the plan details.

The manhole top shall come with a Bilco (36" x 36") Single Leaf Aluminum J-2AL lid, Neenah (Cat No. R-6660-NH) or approved equal. Optional locking hasp shall be included with the lid.

The top slab shall have cast in place lifting lugs designed and rated for lifting the slab.

Manhole steps shall be polypropylene.

A submittal from the manufacturer is required for approval by the Engineer prior to manufacturing.

3. METER shall be 8" Compound Series Meter with (2) "HRE-LCD" (9 Dial, Cubic Feet Read) Slot Screw, Serial No. on Lid manufactured by Badger Meters, Inc. Compete with 25' of Nicor Connectors and (2) Orion CE Transducers. The meter shall be lead free, certified to ANSI/NSF 61 Standards, and meet City of Dayton Meter specifications, latest edition.

   The meter shall be purchased from the Badger Manufacturer Authorized Distributor by the Contractor as follows:

   Buckeye State Pipe & Supply Co. Inc.
   14680 Pleasant Valley Road
   Chillicothe, Ohio 45601
   Attn: Terry Hicks Ph: 740-772-5400

4. OS&Y GATE VALVES shall be 8" resilient wedge OS&Y gate valves designed for potable water service.

   Valve and body shall be of ASTM A126 Class B cast iron with rubber permanently bonded to all interior surfaces and body faces and have flanged end complying with ASTM/ANSI B16.1 Class 125 pattern.

   Shall meet or exceed all applicable requirements of ANSI/AWWA C515 Standards, UL 262 Listed, FM 1120/1130 Approved and certified to ANSI/NSF 61 Standards.

   Valve shall be manufactured by Mueller or an approved equal.

5. CHECK VALVES shall be 8" swing type check valve complete with an outside lever and spring assembly designed for potable water service.

   Valve and body shall be of ASTM A126 Class B cast iron with rubber permanently bonded to all interior surfaces and body faces and have flanged end complying with ASTM/ANSI B16.1 Class 125 pattern.

Shall be manufacturer in conformance to AWWA C508 and certified to ANSI/NSF 61 standards.

Valve shall be manufactured by Kennedy or an approved equal.

6. PIPING AND SPOOL PIECES shall be Ductile Iron Class 53. Flange end shall comply with ASME/ANSI B16.1 Class 125 pattern,

1.03 Installation. Pits, meters, valves and equipment shall be in accordance to the Manufacturer Recommendations, per Technical Sections 800 through 830 and to the Details provided within the drawings. Location and number of each items shall be as shown on the drawing details.

Pipe installation shall be in accordance to Technical Sections 800 – 824 and to the Details provided within the drawings.

Meter installation shall be done by the Contractor utilizing solid spool pieces. Uni-flanges not permitted.

The check valve pit shall be located at least 10 pipe diameters upstream from the meter pit. Uni-flanges are not permitted.

1.04 Measurement. Per meter and check valve assembly (separate meter pit and separate check valve pit) and all piping, meter, valves, check valve, equipment, hatches, supports furnished and installed

1.05 Payment. The price(s) bid shall include furnishing and installing all vaults, meters, pipe, fittings, gate valves, check valves, and joining materials; furnishing materials for and constructing all supports and anchorages; connecting to existing pipelines; and all incidentals items of work necessary to satisfactorily complete and make the fully meters operational.

Item	Unit	Description
SPL-1	EA	Meter Pit and Check Valve Assembly, Complete

END OF METER PIT AND CHECK VALVE ASSEMBLY